

FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
DOVER GAS LIGHT SITE
INTERIM REPORT
GROUND-WATER EVALUATION STUDY

Prepared for:

Chesapeake Utilities Corporation
350 South Queen Street
Dover, Delaware 19901

Prepared by:

Versar, Inc.
6800 Versar Center
Springfield, Virginia 22151

Versar Job No. 6527.107

November 8, 1991

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	General	1
1.2	Site Description	1
1.3	Site History	3
1.4	Geology and Hydrogeology	5
1.5	Compounds of Concern	8
2.0	SOIL BORING ANALYSIS	10
2.1	Methods	10
2.2	Basis of New Well Locations	13
3.0	MONITORING WELL INSTALLATION	16
3.1	Introduction	16
3.2	Monitoring Well Installation	18
3.3	Well Construction	20
3.4	Phase I Ground-Water Sampling	22
4.0	AQUIFER FLOW INFORMATION	22
5.0	SAMPLING RESULTS	26
5.1	Ground Water	26
5.2	Soils	37
6.0	DISCUSSION	51
7.0	CONCLUSIONS AND RECOMMENDATIONS	54
	REFERENCES	57

FIGURES

1-1	Dover Gas Light Site, Dover, Delaware	2
1-2	Monitoring Wells Installed Prior to 1991, Dover Gas Light Site, Dover Delaware	4
1-3	Generalized Cross Section of Pleistocene and Miocene Deposits in Central Delaware	7
2-1	Off-site Boring Locations for Monitoring Well Siting, Dover Gas Light Site, Dover, Delaware	11
3-1	Location of New Monitoring Wells, Dover Gas Light Site, Dover, Delaware	15
3-2	Approximate Elevations of the Bottom of the Columbia Aquifer, Dover, Delaware	19
4-1	Ground-water Elevations in "A" Wells, Columbia Aquifer, Dover, Delaware	24
4-2	Ground-water Elevations in "C" Wells, Dover, Delaware	25
5-1	Total Chlorinated Organic Compounds, Dover, Delaware	31

FIGURES (CONTINUED)

5-2	Total BTEX and Total Semivolatile Organic Compounds for "A" Wells, Dover, Delaware	32
5-3	Total BTEX and Total Semivolatile Organic Compounds for "B" Wells, Dover, Delaware	33
7-1	Proposed Potential Phase II Off-Site Soil Borings, Dover Delaware	56

TABLES

1-1	Chemical Properties of Selected Compounds Found at Dover Gas Light Site	9
2-1	Off-site Boring Sample Results	12
2-2	Off-site Boring Field Observations	14
3-1	Rationale for Well Placement and Screened Intervals, Phase I Well Installation, Dover Gas Light Site	17
3-2	Monitoring Well Construction Data	21
3-3	Field Measurements	23
5-1	Analytical Data for Ground-water Samples, Volatile Organic Compounds	27
5-2	Analytical Data for Ground-water Samples, Semivolatile Organic Compounds	34
5-3	Analytical Data for Ground-water Samples, Total Metals	38
5-4	Analytical Data for Ground-water Samples, Dissolved Metals	43
5-5	Analytical Data for Monitoring Well Soil Samples, Volatile Organic Compounds	48
5-6	Analytical Data for Monitoring Well Soil Samples, Semivolatile Organic Compounds	49
5-7	Analytical Data for Monitoring Well Soil Samples, Total Metals	50

APPENDICES

- A. Off-site Soil Borings, Field Observation Report
- B. Off-site Soil Boring Logs, New Monitoring Well Boring Logs, and New
Monitoring Well Construction Diagrams
- C. Geophysical Logs
- D. Summary Laboratory Analytical Data for Off-site Soil Borings and Ground Water
(Bound Separately)

1.0 INTRODUCTION

1.1 General

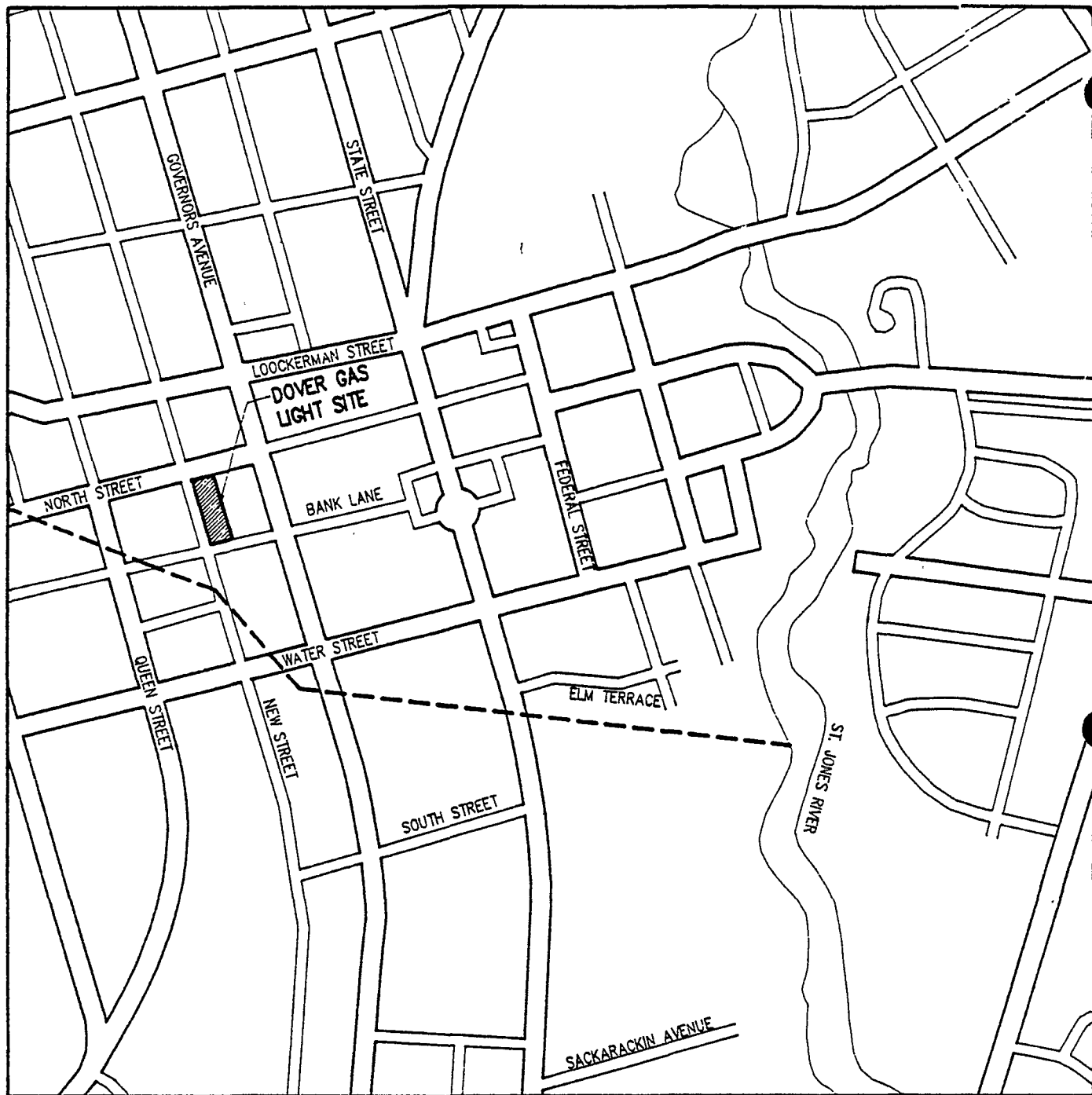
A Ground-Water Evaluation Study was performed for Chesapeake Utilities Corporation (CUC), by Versar, Inc. during June, July, and August 1991 as part of the Remedial Investigation and Feasibility Study (RI/FS) at the Dover Gas Light Site in Dover, Delaware. This report summarizes the data derived from off-site soil borings, 12 new off-site wells drilled during this study period, a new on-site well drilled during April 1991, and ground-water quality data derived from sampling the new wells and existing on-site and off-site wells. The purpose of the well drilling and sampling program was to obtain information regarding the nature and extent of possible impacts within the aquifers underlying the area, in accordance with the approved RI/FS Work Plan, which was approved on June 7, 1991, and the Consent Order. The information obtained from this Ground-Water Evaluation Study will be used to assist in determining the type and extent of remedial actions that may be required, and to determine if a Phase II Ground-Water Evaluation is necessary.

This Ground-Water Evaluation Study is an interim report for the Dover Gas Light Site. Five other interim reports have been submitted describing other aspects of the RI/FS. An Off-site Pathway Analysis report was conducted to determine if a pathway exists or existed between the site and nearby Tar Branch (Versar, 1991c). An On-Site Source Characterization Study (Versar, 1991b) was conducted to provide information regarding the nature and extent of on-site impacts. An Aerial Photographic/Historical Map Investigation Report (Versar, 1991a) was prepared to provide information on previously existing structures at the site. A Phase 1A Archaeological Survey (Engineering-Science, 1991b) was performed to research and identify archaeologically significant areas on site. An Electromagnetometry/Ground-Penetrating Radar (EM/GPR) survey (Engineering-Science, 1991a) was conducted to identify subsurface density and conductivity anomalies that could indicate site-related compounds and the existence of significant subsurface structures such as storage tanks, building foundations, or both.

1.2 Site Description

The Dover Gas Light Site is located in Kent County, Delaware, within the limits of the City of Dover (Figure 1-1). The site occupies the western half of the city block bounded by New Street, Bank Lane, North Street, and Governors Avenue. The site is currently being used as a parking area for the Delaware State Museum and is paved with gravel. Site topography is generally flat, with the exception of a 30- by 40-foot grassy area located on the eastern side of the site. The surface of this latter area is approximately 2 feet higher than the

FIGURE 1-1
DOVER GAS LIGHT SITE, DOVER, DELAWARE.



--- TAR BRANCH



SITE



LOCATION MAP



0 500 1000
SCALE IN FEET

rest of the site and contains a chain fence and several trees. Site drainage is predominantly to the west and south, toward New Street and Bank Lane. Tar Branch, a tributary of the St. Jones River, flows from northwest to southeast approximately 250 feet south and west of the site. The stream discharges into the St. Jones River approximately one-half mile downstream of the site.

1.3 Site History

The Dover Gas Light Company manufactured gas plant produced gas for industrial, commercial, and residential use as well as street lighting, from 1860 to 1948, when operations ceased. The facility originally used resin derived from pine sap as the raw material for gas production. During the Civil War, the process was changed and coking coal, oil, and wood replaced the resin. After 1867, only a coal-gas process was used, which continued until 1948. The plant was dismantled between 1948 to 1949. When in operation, the plant generated various byproducts, including coke, ash, char, and tar. At the completion of demolition activities, one building was left standing, other structures were removed for off-site disposal, and some debris was reportedly buried on-site. The Delaware State Museum occupied this building until the mid-1980s, when it was damaged by fire, demolished, and removed from the site. Currently, the site is used as a parking lot.

A preliminary engineering study was conducted by Duffield Associates (1984) for the Delaware Department of Natural Resources and Environmental Control (DNREC) and revealed that the soil at the site contained a tar-like, aromatic substance. DNREC (1985) sponsored a hydrogeologic investigation that included installation of sixteen monitoring wells (Figure 1-2) in Well Clusters 1 through 5 with the wells screened in the Columbia, Frederica, and Cheswold aquifers. These wells were installed by DNREC around the perimeter of the site between October 22 and November 9, 1984, and were sampled during the week of November 19, 1984. DNREC concluded that compounds from the Dover Gas Light Site had migrated in the ground water of the Columbia aquifer beyond the site boundaries. An additional investigation, performed in 1985 for Chesapeake Utilities Corporation by Versar, Inc. (Versar, 1985), confirmed this earlier conclusion and estimated the extent of the plume. The 1985 investigation involved the installation of seven new monitoring wells (well or cluster numbers 6 through 10) at five locations in the site vicinity. These "A" series wells were constructed similar to the existing (DNREC) shallow wells, and were screened in the upper portion of the Columbia aquifer at an approximate depth of 15 to 30 feet below ground surface (BGS), depending on the location of the water table. At location 6, Well 6B was screened at an intermediate depth in the unconfined aquifer and Well 6C was screened in a thin sand unit, beneath a 2-foot confining clay layer. Ground-water samples were collected and analyzed from each of the 16 existing wells and the 7 newly installed wells.

FIGURE 1-2
MONITORING WELLS INSTALLED PRIOR TO 1991 *
DOVER GAS LIGHT SITE, DOVER, DELAWARE

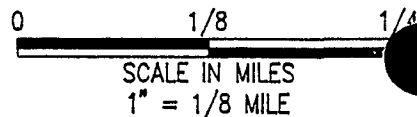


--- TAR BRANCH

- ⊙ CLUSTER OF 3 WELLS, A, B, C
- ⊞ CLUSTER OF 4 WELLS, A, B, C, D
- ▽ WELLS IN PHREATIC AQUIFER, A

* WELLS 1 THROUGH 5 (DNREC, 1984); WELLS 6-10 (VERSAR, 1985)

** WELLS 6B AND 6C HAVE BEEN RENAMED AS 6A 1/2 AND 6B, RESPECTIVELY, DURING THIS STUDY



AR301230

Versar performed an additional study in 1989, in which baseline water level data were collected from the monitoring wells screened within the Columbia and Cheswold aquifers (Berenson, 1989). The purpose of obtaining this information was to determine the degree of hydraulic interconnection between the Columbia and Cheswold aquifers in the site vicinity and to assess the possible risks associated with the potential migration of contaminants between the two aquifers. The compiled data suggested little, if any, hydraulic interconnection between the upper Columbia aquifer, where site-related compounds were found, and the confined Cheswold aquifer, where one City of Dover water supply well is screened. Because no hydraulic interconnection was identified, no imminent hazard to the Dover water supply was found to exist.

1.4 Geology and Hydrogeology

The City of Dover is located in the Atlantic Coastal Plain physiographic province. The land surface slopes gradually toward the east and the St. Jones River. The Atlantic Coastal Plain is composed of sediments deposited during the Cretaceous, Tertiary, and Quaternary Periods. The formations of importance to this study are the Columbia Formation of the Pleistocene Epoch, and the upper part of the underlying Chesapeake Group of the Miocene Epoch. All of the underlying deposits dip to the southeast and increase in thickness from north to south in Kent County (Leahy, 1982).

The Columbia Formation deposits in Kent County are of fluvial origin and consist of poorly sorted, yellow, brown, and white fine- to coarse-grained sands with minor clay and silt lenses. The Columbia Formation thickens in a southward direction and extends from the ground surface to about 20 to 37 feet below sea level at Dover, or roughly 50 to 70 feet BGS. Beneath the site, the Columbia is approximately 58 to 65 feet thick and unconformably overlies the Miocene sediments (Johnston, 1973; Versar, 1991b). The base of the formation slopes toward the southeast. The Columbia aquifer is the surficial aquifer within the general site area. The iron content of the water in this aquifer is often high and the formation materials are commonly iron-stained (Woodruff, 1972; Versar, 1991b).

The Miocene sediments of the Chesapeake Group are generally sandy, but contain greater amounts of silt and clay than the Columbia. The Chesapeake Group comprises blue to gray silts, shells, and fine- to medium-grained sands. The upper part of the Chesapeake Group consists of alternating strata of semi-confining layers and more permeable sandy layers. The sharp contact between the Pleistocene and Miocene is distinguished by both a lithologic change and a color change, from orange and tan sands to a stiff blue-gray silty clay. The clay gradually coarsens downward to silt, and is interspersed with fine sand stringers until the first distinct sand zone, greater than 2 feet thick, is encountered, which is the Frederica

aquifer. In the Dover area, at least two sand horizons are areally persistent and are known as the Frederica (upper) aquifer, and the Cheswold (lower) aquifer (Woodruff, 1972). A third sand unit, the Federalsburg, is sometimes identified between these two aquifers, but is not always present in the Dover area.

The multiple strata of the upper Chesapeake Group have low enough transmissivity values that, in at least one study involving a numerical simulation (Leahy, 1982), all of the strata were considered part of the thick, confining layer that separates the Columbia aquifer from the Cheswold aquifer. The 80-foot thick confining layer above the Cheswold is composed of layers of silt, clay, and fine-grained sand showing evidence of shells (Versar, 1985). This thick confining layer in the Dover area provides a good separation between the Cheswold aquifer and the overlying aquifers of the upper Chesapeake Group and Columbia Formation.

The study area is underlain by three principal aquifers, the Columbia, Frederica, and Cheswold. The Columbia aquifer, the uppermost aquifer in the study area, is the unconfined aquifer that lies within the Columbia Formation. Currently the Columbia aquifer is not known to be used as a potable water supply source within the City of Dover (Versar, 1991d). Directly underlying the Columbia are interlayering sediments of the Chesapeake Group, including the Frederica, and Cheswold aquifers. The Cheswold is currently used for part of the municipal water supply for the City of Dover. Figure 1-3 illustrates the Cheswold aquifer occurring as a subcrop below the unconfined Columbia aquifer near Smyrna, and the Frederica aquifer in a similar relationship at Dover. Smyrna is located about 10 miles northwest of downtown Dover. The Cheswold aquifer subcrop is a 1- to 3-mile strip that runs roughly parallel to the Kent County/New Castle County line (Leahy, 1982). The closest edge of the subcrop area is located about 4 miles northwest of the Dover City limits. The Frederica aquifer subcrops the Columbia Formation in the Dover area (Pickett and Benson, 1983). The Frederica aquifer subcrop occurs in a 2- to 3-mile wide strip oriented on a northeasterly line that encompasses the City of Dover. The City of Dover and the Dover Gas Light site are located on or south of the Frederica subcrop.

The City of Dover municipal water is supplied by 14 ground-water production wells operated by the City of Dover. The municipal wells are capable of pumping over 10 million gallons per day (MGD) (Dover, 1975). The wells, which are distributed throughout the city, withdraw water from the deeper Cheswold and Piney Point aquifers. In 1983, the city pumped 2.5 MGD from the Cheswold aquifer (DNREC, 1985). The major recharge for the Cheswold aquifer is by vertical leakage from the unconfined aquifer about 5 miles northwest of the city (Johnston and Leahy, 1977). The Cheswold aquifer was sampled in 1985 and no site-related compounds were detected. Only City of Dover Well No. 9 (screened interval 180 feet to 230

FIGURE 1-3
GENERALIZED CROSS SECTION OF PLEISTOCENE
AND MIOCENE DEPOSITS IN CENTRAL DELAWARE

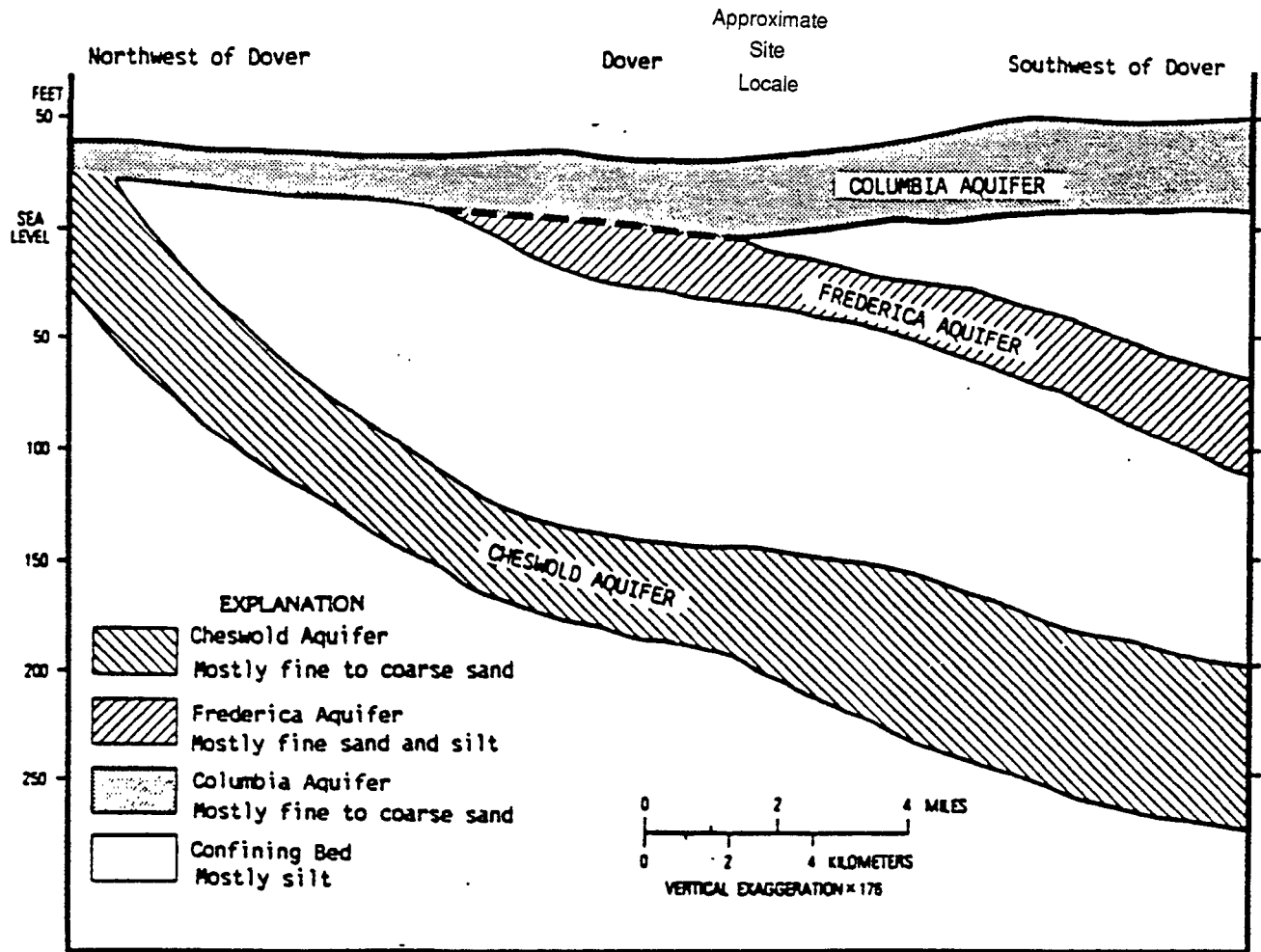


Figure modified from Johnston and Leahy (1977).

feet BGS) and City of Dover Well No. 12 (screened interval 316 feet to 396 feet BGS) are located hydraulically downgradient from the site. Of these two wells, only City of Dover Well No. 9 is screened within the Cheswold aquifer, approximately 0.40 mile from the site. It has been demonstrated that no significant hydraulic connection exists between the Columbia and Cheswold aquifers (Berenson, 1989). City of Dover Well No. 12 is screened within the underlying Piney Point aquifer, which is judged to be too deep to be affected by the site (Versar, 1985; RI/FS Work Plan).

1.5 Compounds of Concern

The primary compounds associated with the site include polycyclic aromatic hydrocarbons (PAHs); benzene, toluene, ethylbenzene, and total xylenes (BTEX); and styrene (Versar, 1991b). PAHs, BTEX, and styrene are all predominant constituents of various coal tar fractions. The base-neutral acid extractable (BNA) compound analysis includes PAHs, along with other semi-volatile organic compounds. Laboratory analysis for volatile organic compounds (VOCs) includes BTEX and styrene, along with other volatiles. Table 1-1 is a summary of some pertinent physical and chemical properties of selected PAH compounds and BTEX along with selected data from the On-site Source Characterization Study (Versar, 1991b). The data included in this table show a general range of PAHs and BTEX concentrations that were detected in samples from the old gas holder foundations (B-2 and B-4) as well as from a central area of the site (B-14). Data from these soil boring locations were chosen because they are generally representative of current site conditions. The BTEX compounds are more soluble than PAHs in water and are somewhat less likely to be adsorbed by surrounding soil matter. Generally, the PAH compounds are only slightly soluble in water and are strongly adsorbed to sediments and soils. This is demonstrated by the high soil/water partition coefficients presented in Table 1-1. As the molecular weight of these compounds increases, there is an exponential decrease in solubility and volatility.

Data from previous studies indicate that the shallow ground water in the Columbia Aquifer underlying the site has been affected by site-related compounds as well as by other sources, such as leaking underground storage tanks (Versar, 1985; DNREC, 1985). It is believed that infiltrating water has percolated through the unsaturated zone at the site and leached soluble constituents of the coal tar residue. Other less soluble constituents that are separate liquid phases may have migrated downward through the unsaturated (vadose) zone into the Columbia aquifer under the influence of gravity. At elevated concentrations above the limit of solubility, these compounds can exist as a separate, immiscible liquid phase that is either denser or lighter than water. This depends upon the specific gravity of the constituents and the chemistry of the aquifer. Most often, volatile organic compounds are found in the lighter phases, while the base/neutral acid extractables (BNAs) are often found to be more

TABLE 1-1

CHEMICAL PROPERTIES OF SELECTED COMPOUNDS FOUND AT DOVER GAS LIGHT SITE

<u>Parameter</u>	<u>Waste Concentration Range (µg/kg)*</u>	<u>Water Solubility (mg/L)**</u>	<u>Soil/Water Partition Coefficient (Koc)**</u>
<u>Polycyclic Aromatic Hydrocarbons (PAHs)</u>			
Naphthalene	2,000-13,000	31.7	940
Acenaphthylene	550-1,400	3.93	2,500
Acenaphthene	150	3.42	4,600
Fluorene	390-870	1.69	7,300
Phenanthrene	280-2,600	0.42	14,000
Fluoranthene	330-960	0.26	38,000
Anthracene	68-700	0.045	14,000
Pyrene	150-1,100	0.032	38,000
Benzo(a)anthracene	54-540	0.006	1,380,000
Indeno(1,2,3-cd)pyrene	10,000	0.005	1,600,000
Benzo(a)pyrene	39-430	0.004	5,500,000
<u>BTEX and Other Volatile Organics</u>			
Benzene	89-2,100	1,780	83
Toluene	130-1,800	535	300
Ethylbenzene	97-120	152	1,100
Total xylenes	150-870	198	240
Styrene	49-620	300	430

Note:

* Data from on-site soil borings (locations B2, B4, and B14).

** Values presented in EPA's Toxics Data Base, 1990. Developed for OWRS/AWPD by Versar, Inc.

µg/kg - Micrograms per kilogram or parts per billion (ppb).

mg/L - Milligrams per liter or parts per million (ppm).

Koc - Organic carbon partition coefficient.

dense than water. The lighter nonaqueous phase liquids (LNAPL) will tend to rise and may be found as a layer along the water table, "floating" on the phreatic surface. They may also exhibit a horizontal flow component, although this may be at a different velocity than the ground water. To detect such a phase, it is preferable to locate the well screen so that it intersects the water table (consistent with the "A" Series wells). The heavier immiscible organics also exhibit a horizontal flow component, as well as a downward "sinking" effect; therefore, a well screen located at the bottom of the aquifer (above a confining layer) is preferable for intercepting dense immiscible phases (DNAPL) (consistent with "B" Series wells).

Evidence for stratification, with VOCs present near the top of the aquifer, and semi-volatiles near the bottom of the aquifer, was found during the 1985 Versar study. The rate at which the coal tar constituents may migrate through the unsaturated and saturated zones is a function of the hydraulic gradient of the affected area and contaminant/soil interactions (e.g., sorption) that tend to retard the rate of migration. Some organic compounds potentially originating either from coal tar residues or other petroleum hydrocarbon sources have been noted in several of the monitoring wells located in the Columbia aquifer downgradient from the site.

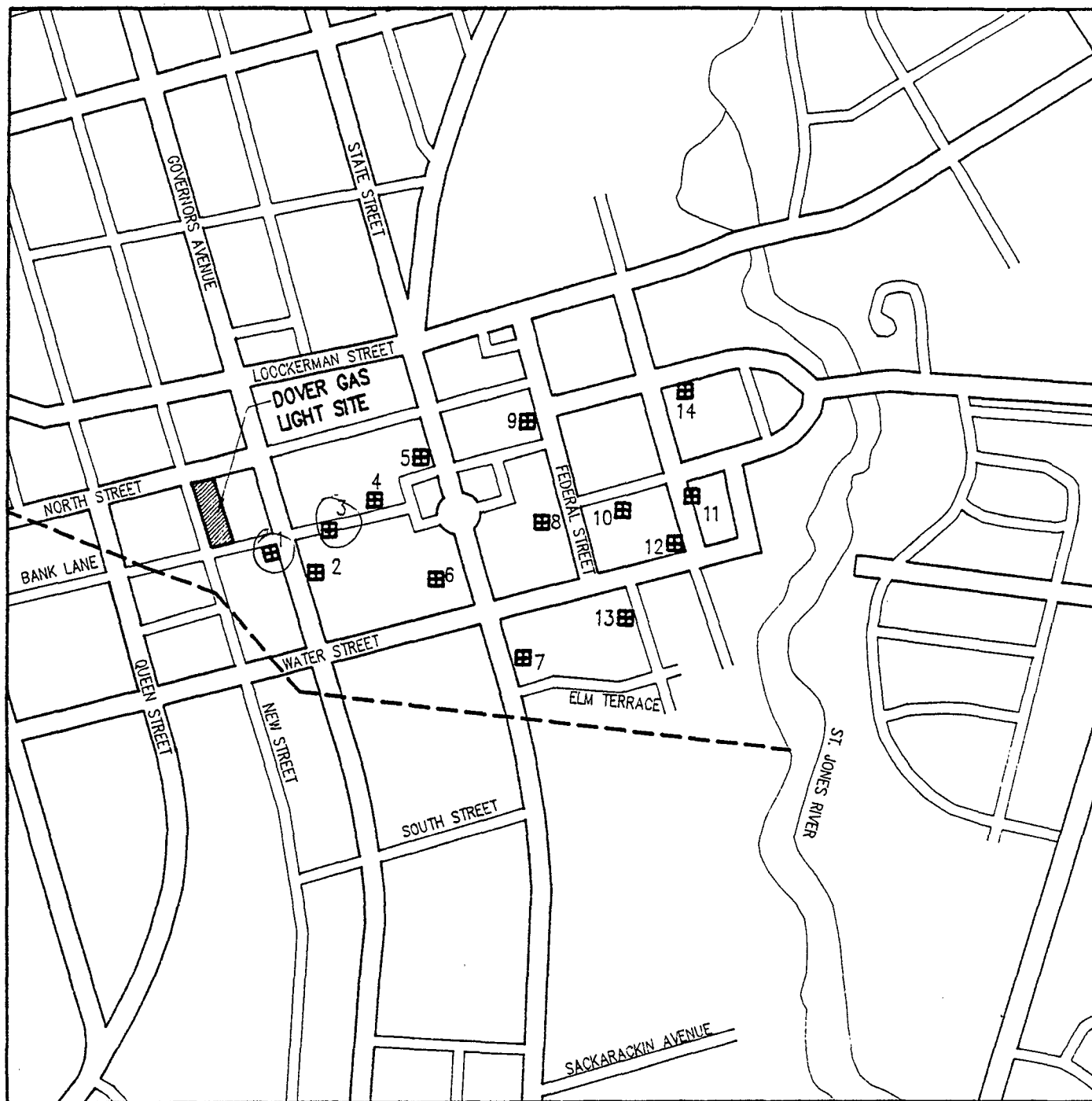
2.0 SOIL BORING ANALYSIS

An off-site soil boring program was conducted to aid in the delineation of the areal extent of soil impacted within the Columbia aquifer, and to determine the most practical locations for new monitoring wells for this study. The results will be used in the RI to estimate the center and downgradient limits of a probable off-site ground-water plume.

2.1 Methods

Continuous soil samples were taken with a split-spoon sampler from 5 feet above to 5 feet below the water table in the fourteen off-site borings (Figure 2-1). The samples were screened in the field using a portable photoionization detector (HNU) to detect the presence of VOCs and a HNU-Hanby field extraction and testing kit to detect total recoverable petroleum hydrocarbons (TRPH). All samples were screened for evidence of organic contamination, including staining, odors, and elevated organic vapor readings. On this basis, ten samples were collected and submitted to the Versar laboratory for volatile and semi-volatile organic analysis. Obviously contaminated samples having noticeable odors or soil discolorations, such as at borings 1 and 3, were not analyzed in the laboratory in accordance with discussions conducted by the DNREC, Versar, the EPA, and Chesapeake Utilities on April 25, 1991. Most of the 10 analytical samples were collected from immediately above the water table. Table 2-1 is a list of sample locations, depths, field screening results, and analytical

FIGURE 2-1
OFF-SITE BORING LOCATIONS
FOR MONITORING WELL SITING, DOVER GAS LIGHT SITE, DOVER, DELAWARE



- TAR BRANCH
- SITE
- OFF-SITE BORING LOCATIONS



0 500 1000
SCALE IN FEET

TABLE 2-1
OFF-SITE BORING SAMPLE RESULTS

<u>Sample No.</u>	<u>Depth (ft BGS)</u>	<u>Field* Headspace (ppm)</u>	<u>Field** TPH (ppm)</u>	<u>Laboratory*** 8240 CLP-VOA</u>
OB1	11-13	50	200	NA
OB2	9-11	6	0-1	NA
OB3	13-15	50	5-25	NA
OB4	13-15	3	0-1	ND
OB5	19-21	10	0-1	ND
OB6	13-15	3	0-1	ND
OB7	13-15	6	0-1	ND
OB8	15-17	7	0-1	ND
OB9	15-17	4	0-1	ND
OB10	17-19	6	0-1	11 µg/L Acetone****
OB11	13-15	3	0-1	ND
OB12	15-17	10	0-1	5 µg/L Tetrachloroethene
OB13	17-19	12	0-1	ND
OB14	13-15	1	0-1	14 µg/L Acetone****
Blank	--	--	NA	ND

Note:

- * Photoionization Detector - Relative readings in ppm.
- ** Total Petroleum Hydrocarbons - Hanby Test Kit, relative readings calibrated to ppm.
- *** EPA Contract Laboratory Program, Statement of Work for Organics Analysis, Rev. February 1988.
- **** Probable Laboratory Contaminant.
- NA = Not analyzed.
- ND = Not detected above method detection limits.

results for the borings. Only VOC data are shown because no BNAs were detected in any of the samples. Table 2-2 shows a summary of off-site boring field observations. Appendix A is a report of field observations made during the boring effort. Summary laboratory reports are provided in Appendix D. Complete copies of all laboratory reports will be provided as required for completion of the final RI report.

6/12/91
TLO

2.2 Basis of New Well Locations

Results of the off-site boring field observations, field screening, and laboratory analysis of boring soil samples, combined with information from previous studies, confirmed that the proposed new monitoring Well Cluster 11 location shown in the RI/FS Work Plan was appropriate. The results further indicated that the RI/FS Work Plan proposed Well Clusters 12 and 13 should be relocated to more optimum locations.

No evidence of organic compounds other than acetone was noted in Borings 5, 9, or 14; therefore, ~~site-related~~ organic compounds have not migrated toward the northeast. Field observations noted a diesel odor and dark staining at Boring 10, and an elevated HNu reading at Boring 12. Based on this information, Versar recommended, and the DNREC and EPA approved (Sullivan memo, July 16, 1991), moving Well Clusters 12 and 13 from the locations shown in the RI/FS Work Plan. The new locations would be beyond the apparently clean borings and those borings where evidence of potential hydrocarbon compounds was detected. This move would provide an enhanced opportunity for estimating the location of the northern edge of any potential plume. Well Cluster 13 was moved approximately 500 feet south and Well Cluster 12 was moved approximately 400 feet southwest. Well Cluster 12 could not be moved any further south due to overhead construction and surface obstructions. Final locations of new off-site monitoring wells are shown in Figure 3-1.

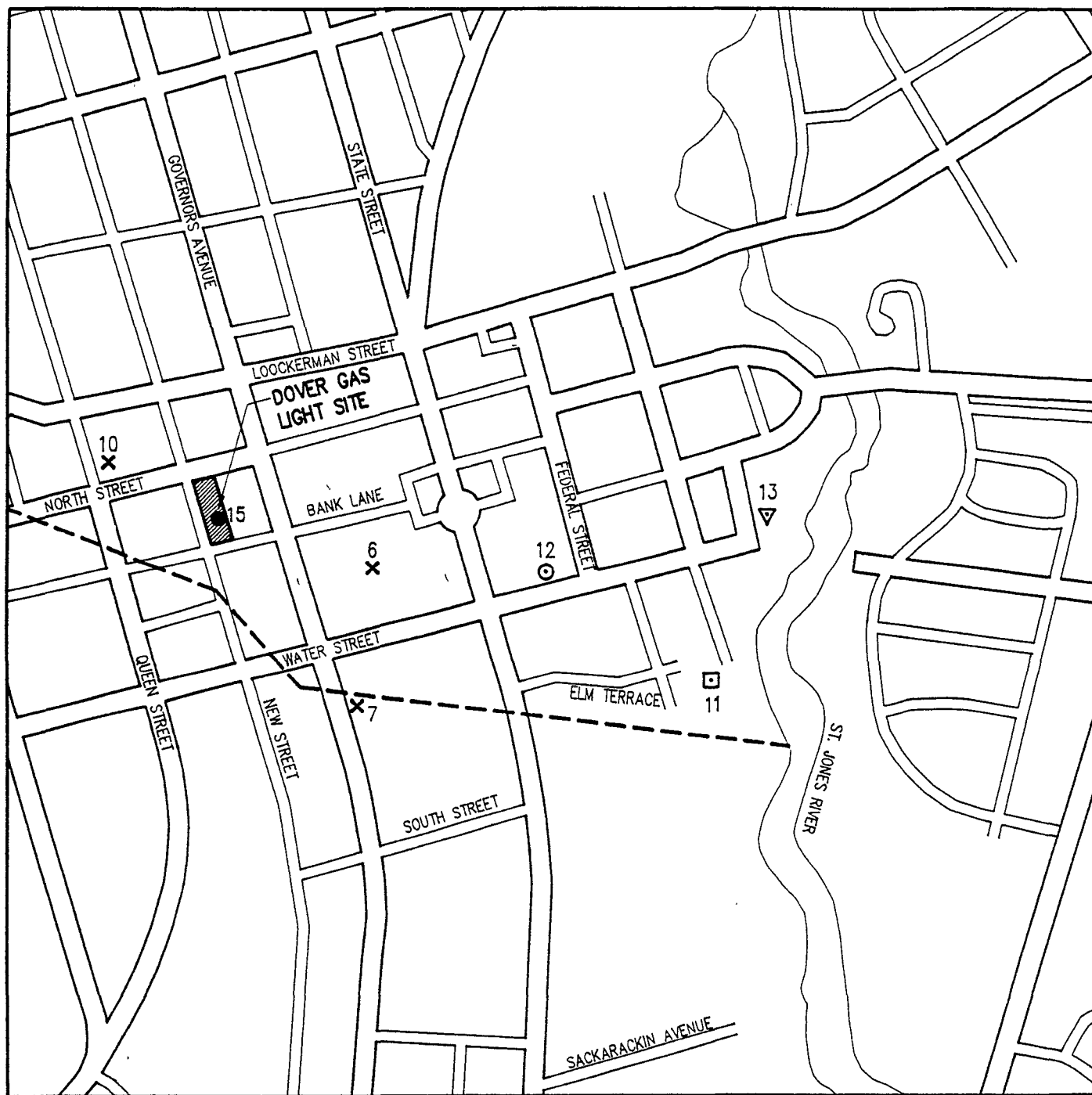
Changes
Sullivan

Field observations and screening at Borings 1 and 3 showed evidence of site-related compounds. Previous studies indicated that site-related compounds were found in Well Cluster 6; however, there was no evidence of site-related compounds in Boring 6, even though it appears to be downgradient of Well Cluster 6. Although field observations at Boring 13 included detection of hydrocarbon-like odors, field testing showed only a slightly elevated headspace result and subsequent laboratory analysis showed no evidence of site-related compounds; therefore, the proposed location of Well Cluster 11, when considered along with other information, was considered appropriate to provide additional information for defining the limits of potential impacts south and east of the site.

TABLE 2-2
OFF-SITE BORING FIELD OBSERVATIONS

<u>Sample No.</u>	<u>Date</u>	<u>Observation Summary</u>
OB1	06/13/91	HNu @ 20 ppm in boring @ 11-13 feet. Distinct odor.
OB2	06/12/91	No discoloration or odors noted.
OB3	06/13/91	Distinct odor and soil discoloration at 13-15 feet. HNu @ 10 ppm.
OB4	06/13/91	No discoloration or odors noted. HNu @ 0 ppm.
OB5	06/19/91	Humic odor. Dark specks, possibly degraded humic materials.
OB6	06/12/91	No discoloration or odors. HNu @ 1 ppm.
OB7	06/14/91	Top zone clean, lower zone had odors and black stains.
OB8	06/15/91	No odors, low HNu reading.
OB9	06/18/91	HNu @ 1 ppm in top spoon. No odors. Black specks possibly due to iron staining.
OB10	06/17/91	Some dark bands @ 17-19 feet. Slight diesel odor.
OB11	06/19/91	HNu @ 6 ppm in upper spoon. No odors, slight traces of dark materials, humic origin.
OB12	06/18/91	HNu @ 12 ppm at 15-17 feet. No odors. Dark specks due to iron staining.
OB13	06/14/91	Slight odor @ lower zone near water table.
OB14	06/15/91	No odor, some bands of humic material.

FIGURE 3-1
LOCATION OF NEW MONITORING WELLS
DOVER GAS LIGHT SITE, DOVER, DELAWARE.



--- TAR BRANCH



SITE

● "A" WELL

× "C" WELL (NEAR PREVIOUSLY
INSTALLED WELLS)

▽ CLUSTER OF 2 WELLS, A, B

○ CLUSTER OF 3 WELLS, A, B, C

□ CLUSTER OF 4 WELLS, A, B, C, D



LOCATION MAP



0 500 1000

SCALE IN FEET

3.0 MONITORING WELL INSTALLATION

3.1 Introduction

Based on the results obtained from soil borings, locations for 12 new off-site monitoring wells were selected to delineate the potential plume. At each designated ground-water monitoring location, up to four wells were positioned in clusters similar in design to previously installed wells (Well Clusters 1 through 5, with the four well designations "A", "B", "C", and "D"). The "A" wells were installed so that each well screen intercepted the phreatic surface (water table) of the Columbia aquifer and, therefore, was suitable to collect, if present, volatile organic compounds that are less dense than water. The "B" wells were installed in the same uppermost unconfined aquifer as the "A" wells, but were screened at a lower elevation near the confining zone and, therefore, were suitable to intercept heavier, more dense organic compounds. The "C" wells were installed and screened to intercept ground water within the Frederica aquifer. One "D" well was installed in the Cheswold aquifer.

Well locations were selected and approved based on available analytical data from the off-site soil borings, data from previous reports, and logistical considerations related to site access, as well as development within the city limits and the necessity to locate wells on city or state property. The selection of specific well locations was coordinated with the State of Delaware Division of Historical and Cultural Affairs to avoid disturbance of potentially significant archaeological artifacts. Because of the complex network of underground utilities in the area, representatives from the City of Dover, other utilities, and the state Division of Facilities Management aided in the selection of each well location. Figure 3-1 shows the new well locations and the type of well or well cluster that was placed at each location. Table 3-1 is a list of these wells and the rationale for each well location and screened interval.

New wells installed during 1991 included a "C" well at location 7, a three-well cluster ("A", "B", and "C") at location 12, a four-well cluster ("A", "B", "C", "D") at location 11, a two-well cluster ("A" and "B") at location 13, a combination A/B well at location 15 (on-site), and an upgradient "C" well at location 10. A "C" well at location 14 was originally scheduled to be installed, however this was deferred until Phase II, if required, as approved by DNREC on August 3, 1991. In addition, a replacement well was installed at location 6C because the original Well 6C was found to be screened in the lower portion of the Columbia aquifer.

The new Well 6C is screened in the Frederica at a depth of 78 feet BGS. The old Well 6C was renamed 6B, and the old Well 6B was renamed 6A1/2 because it was previously screened above the appropriate depth interval. Well 15A/B, which is located on-site, was installed during the on-site soil boring study in April, 1991. Well 15A/B was originally intended

TABLE 3-1

**RATIONALE FOR WELL PLACEMENT AND SCREENED INTERVALS
PHASE I WELL INSTALLATION
DOVER GAS LIGHT SITE**

<u>Well No.</u>	<u>Approx. Screened Interval (with respect to mean sea level)</u>	<u>Rationale</u>
7C	-40 to -50	Provide downgradient information on Frederica and greater number of points for gradient determination.
10C	-40 to -50	Provide an upgradient well location in Frederica as well as more head data (background for Frederica aquifer).
11A	10 to 0	Provide downgradient "edge of plume" on Columbia aquifer at southern part of expected plume. Screened across water table for light immiscible detection. Use to monitor water levels during pump testing of nearby monitor and municipal wells.
11B	-10 to -20	Same as 11A, but screened at bottom of Columbia for dense immiscible detection. Also used for pump test observation well.
11C	-40 to -50	Same as 11A, but for Frederica aquifer.
11D	-150 to -160	Provide head data in Cheswold aquifer during pump test of municipal wells.
12A	10 to 0	Same as 11A, however, located in central area of expected plume. Also a pump test observation well.
12B	-10 to -20	Same as 11B, but located in central area of expected plume. Also a pump test observation well.
12C	-40 to -50	Same as 11C, but in central plume area. Scheduled for pump testing.
13A	10 to 0	Provide downgradient edge of plume in Columbia. Screened across water table to collect light immiscibles.
13B	-10 to -20	Same as 13A, but screened at bottom of aquifer to collect dense immiscibles.
15A/B	10 to -20	Screened across partial thickness of Columbia aquifer to provide accurate pump test results on site.

to screen the entire Columbia aquifer, to a depth of approximately 60 feet BGS, for pump testing. However, because of the presence of subsurface oily materials and the presence of a semiconfining clay zone at 25 feet BGS, it was determined that a fully penetrating well would possibly provide a conduit for migration of dense organic constituents into the lower aquifer. To avoid downward migration, the well was screened from just above the water table to 25 feet BGS. Well 15A/B will be considered an "A" well for purposes of this report. In total, 13 new wells were installed in 1991 to delineate the boundaries of the site-related ground-water plume and to test aquifer characteristics.

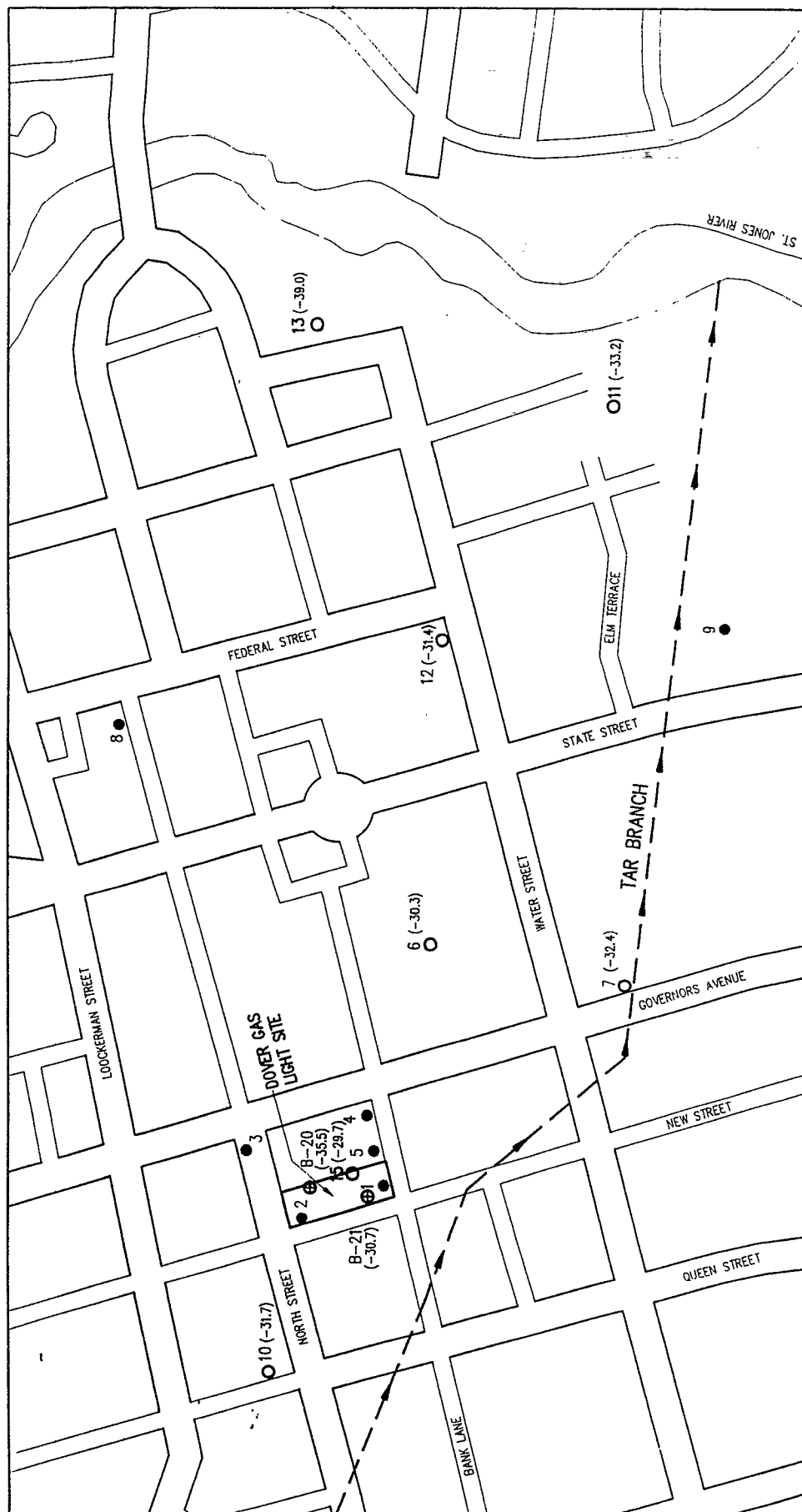
Figure 3-2 illustrates the relative elevations of the bottom of the Columbia aquifer, as derived from both on-site and off-site borings and well boring data. Contours were not drawn due to the expected variable nature of this erosional surface, which may slope steeply across small areas; however, the general slope of the erosional surface can be inferred from this diagram.

3.2 Monitoring Well Installation

Shallow monitoring well borings (all "A" wells and two "B" wells) were drilled with a CME 750 rotary drilling rig equipped with hollow-stem augers. Deep well borings, including all "C" wells and one "B" well, were drilled with a Kelly 1250 rotary drilling rig using water rotary methods and a drag bit. Well 11D was originally drilled with water rotary methods, but was redrilled using mud rotary methods. Only pure sodium bentonite mud was used to drill this well boring. Split-spoon samples were collected at 5-foot intervals for stratigraphic characterization when no previous existing log was available, such as in the deepest and first boring in a well cluster. More frequent split-spoon samples were taken near confining zones or within the capillary fringe zone, approximately 5 feet above to 5 feet below the water table. In areas of apparent organic contamination, as indicated by the presence of staining, odors, or detection of organic vapors by a photoionization device (PID), such as an HNu, soil samples were collected and submitted to the Versar laboratory for volatile and semi-volatile organic compounds analysis. A total of six samples were submitted for laboratory analysis. Results of these analyses are discussed in Section 5.2. Copies of the well logs are contained in Appendix B. Laboratory summary reports are provided in Appendix D.

One Shelby tube sample for bulk density analysis was taken in the middle portion of the confining zone between the Columbia and Frederica aquifer during the drilling of Well 12C. This was to further verify information that will be collected during the aquifer testing phase of the RI. The bulk density of the sample was 141 lb/ft³.

FIGURE 3-2
APPROXIMATE ELEVATIONS OF THE BOTTOM OF THE COLUMBIA AQUIFER
DOVER, DELAWARE



DATE: 11-05-91

Borehole geophysical logging, using resistivity and gamma logs, was performed in well borings 11D, 6C, and 13B to aid in stratigraphic characterization and screen placement. This information was correlated with lithologic data from the split-spoon samples to verify the stratigraphy in areas that might be questionable due to sampling difficulties. The geophysical logs are contained in Appendix B. In general, the geophysical logs confirmed the lithological data obtained from the split-spoon samples, thus verifying the optimum vertical location for well screen placement.

3.3 Well Construction

Monitoring wells were constructed of flush-threaded, 4-inch or 5-inch inside diameter (I.D.) schedule 40 polyvinyl chloride (PVC) casing and screens. The choice of schedule 40 PVC as the well construction material was based upon compatibility with the 23 existing wells, which are all constructed of the same material. All newly installed "A", "B", "C", and "D" wells are 4 inches I.D. Well 15A/B is 5 inches I.D. to facilitate equipment and pump placement during pump testing. Screens are 15 feet in length for "A" wells and 10 feet in length for "B", "C", and "D" wells. The "A" well screens were placed so that the upper 5 feet of the screen are above the water table and the lower 10 feet are below the water table. All well screens are factory slotted No. 20 (0.020 inch) slot size.

The annulus around each well screen was packed with No. 1 or No. 2 Morie sand to approximately 2 feet above the top of the screen. A minimum 2-foot thick bentonite seal was then placed on top of the sand pack. The remaining annular space was filled with bentonite grout to just below the frost line, followed by concrete to the ground surface. All wells were equipped with a locking cover and inner expansion-type cap. Some wells were equipped with flush-mounted covers depending on well location. Appendix B contains well construction diagrams that show the well construction details.

Completed wells were developed by either using air-lift methods or by pumping continuously to remove suspended sediments and to achieve optimum hydraulic connection (i.e., repair disturbance of the aquifer due to drilling). Wells were developed until the water was as free from turbidity as possible.

Well casings were surveyed with reference to the nearest U.S. Geological Survey benchmark (BM M34). The vertical and horizontal location of each well was established to within 0.01 feet and 1 foot, respectively. Table 3-2 is a list of casing and ground surface elevations, well depths, water elevations, and screen lengths for previously installed and new monitoring wells.

TABLE 3-2
MONITORING WELL CONSTRUCTION DATA

Location:	Elevation: Top of Casing	Surface Elevation	Depth to Water * (BTOC)	Water Surface Elevation	Depth to Bottom of Well (BTOC)	Screen Length	Depth to Water# (BTOC)	Water Surface Elevation
MW1A	23.00	22.99	8.81	14.19	26.02	10	9.28	13.72
MW2A	26.62	26.57	12.81	13.81	19.45	10	12.4	14.22
MW3A	30.14	30.35	16.26	13.88	23.52	10	N/A	N/A
MW4A	27.45	27.60	14.05	13.4	28.91	15	14.51	12.94
MW5A	25.93	25.96	12.12	13.81	26.1	10	12.61	13.32
MW6A	27.37	27.70	14.87	12.5	20.92	15	16.43	10.94
MW6A1/2	27.46	27.71	15.00	12.46	36.04	15	15.56	11.9
MW7A	17.38	16.86	4.65	12.73	23.21	15	5.29	12.09
MW8A	27.74	26.73	18.21	9.53	32.05	N/A	18.68	9.06
MW9A	10.84	10.10	1.95	8.89	20.65	15	2.01	8.83
MW10A	26.26	26.19	13.21	13.05	22.82	N/A	10.85	15.41
MW11A	10.20	8.70	6.66	3.54	20.42	15	6.07	4.13
MW12A	26.60	27.00	17.52	9.08	25.8	N/A	17.95	8.65
MW13A	19.29	19.69	13.35	5.94	17.45	15	13.7	5.59
MW15A/B	26.59	27.34	12.25	14.34	23.95	20	13.11	13.48
MW1B	23.00	22.99	8.71	14.29	43.51	10	9.21	13.79
MW2B	26.55	26.57	11.81	14.74	46.05	10	12.36	14.19
MW3B	30.16	30.41	16.31	13.85	50.86	10	N/A	N/A
MW4B	27.44	27.66	13.98	13.46	49.73	10	14.47	12.97
MW5B	25.76	26.04	12.85	12.91	49.87	10	12.35	13.41
MW6B	27.95	27.79	15.66	12.29	61.05	10	16.12	11.83
MW11B	10.36	8.56	5.73	4.63	46.48	10	4.52	5.84
MW12B	26.75	27.10	18.97	7.78	60.67	15	18.36	8.39
MW13B	19.67	19.98	15.24	4.43	56.39	10	14.19	5.48
MW1C	22.98	22.86	15.93	7.05	74.69	10	15.15	7.83
MW2C	26.79	26.61	17.85	8.94	77.68	10	17.93	8.86
MW3C	30.05	30.44	16.18	13.87	71.61	10	N/A	N/A
MW4C	27.60	27.78	18.98	8.62	75.58	10	20.25	7.35
MW5C	25.88	26.11	13.94	11.94	74.00	10	14.26	11.62
MW6C	27.33	27.73	28.25	-0.92	78.27	10	28.21	-0.88
MW7C	15.85	16.12	8.11	7.74	83.21	10	8.24	7.61
MW10C	25.88	26.30	13.80	12.08	87.8	10	14.48	11.4
MW11C	10.33	8.74	21.38	-11.05	76.21	10	20.69	-10.36
MW12C	26.79	27.06	N/A	N/A	N/A	10	37.06	-10.27
MW5D	26.32	26.33	102.00	-75.68	167.33	10	98.59	-72.27
MW11D	10.55	8.83	N/A	N/A	N/A	10	83.34	-72.79

Notes:

1. Elevations are in feet above mean sea level
 2. Depths and lengths are in feet
 3. N/A - Information not available
 4. BTOC - Below Top of Casing
- * - Measurements taken during the week of August 11, 1991
- Measurements taken on November 1, 1991

3.4 Phase I Ground-Water Sampling

Following monitoring well installation, one set of ground-water samples was collected during the week of August 11, 1991, from all monitoring wells associated with the Dover Gas Light Site for use in determining the extent of ground-water impact. This effort included the 16 wells originally installed by the State of Delaware, 7 wells installed by Versar in 1985, and the 13 newly installed wells. All samples were collected using methods consistent with Test Methods for Evaluating Solid Waste (U.S. EPA, SW-846, Third Edition, November 1986) and the RCRA Ground-water Monitoring Technical Enforcement Guidance Document (U.S. EPA, September 1986), as outlined in the RI/FS Work Plan. Samples from each well were collected and analyzed for VOCs, BNAs, and total and dissolved metals. In situ field measurements, including temperature, pH, and conductivity are presented in Table 3-3. Depth to water and total well depth were measured to the nearest 0.01 foot. Laboratory summary reports are provided in Appendix D.

Because of the possible presence of floating or sinking immiscible layers within the monitoring wells, measurements of these potential layers were undertaken in each well. An interface probe was used to detect immiscible layers in each well prior to well purging. No immiscible layers were detected in any wells by the interface probe. Although not measurable, a sheen was observed in Well 6A1/2 during purging activities.

4.0 **AQUIFER FLOW INFORMATION**

Ground-water elevations were measured during ground-water sampling activities during the week of August 11, 1991, and on November 1, 1991, and are shown in Table 3-2. Figure 4-1 shows the water level in the "A" series of wells, which is believed to be representative of the location of the water table in the Columbia aquifer. The water elevation in Well 5A was not used in determining the water table due to an anomalously high elevation reading. Figure 4-2 illustrates the ground-water surface elevations measured in the "C" wells, which is indicative of the piezometric surface of the Frederica aquifer. Again, the water level in 5C was not used due to an anomalously high elevation reading. The average gradient in the Columbia aquifer is approximately 0.0048, as determined from water levels observed between August 13 to 17, 1991. The average gradient in the Frederica aquifer is approximately 0.0101, as determined from water levels observed on November 1, 1991.

From the water level elevations observed in the Columbia aquifer ("A" wells) during the week of August 13, 1991, and on November 1, 1991, it appears that there may be a slight downward gradient from the site toward Well Cluster 10. This condition was not noted during

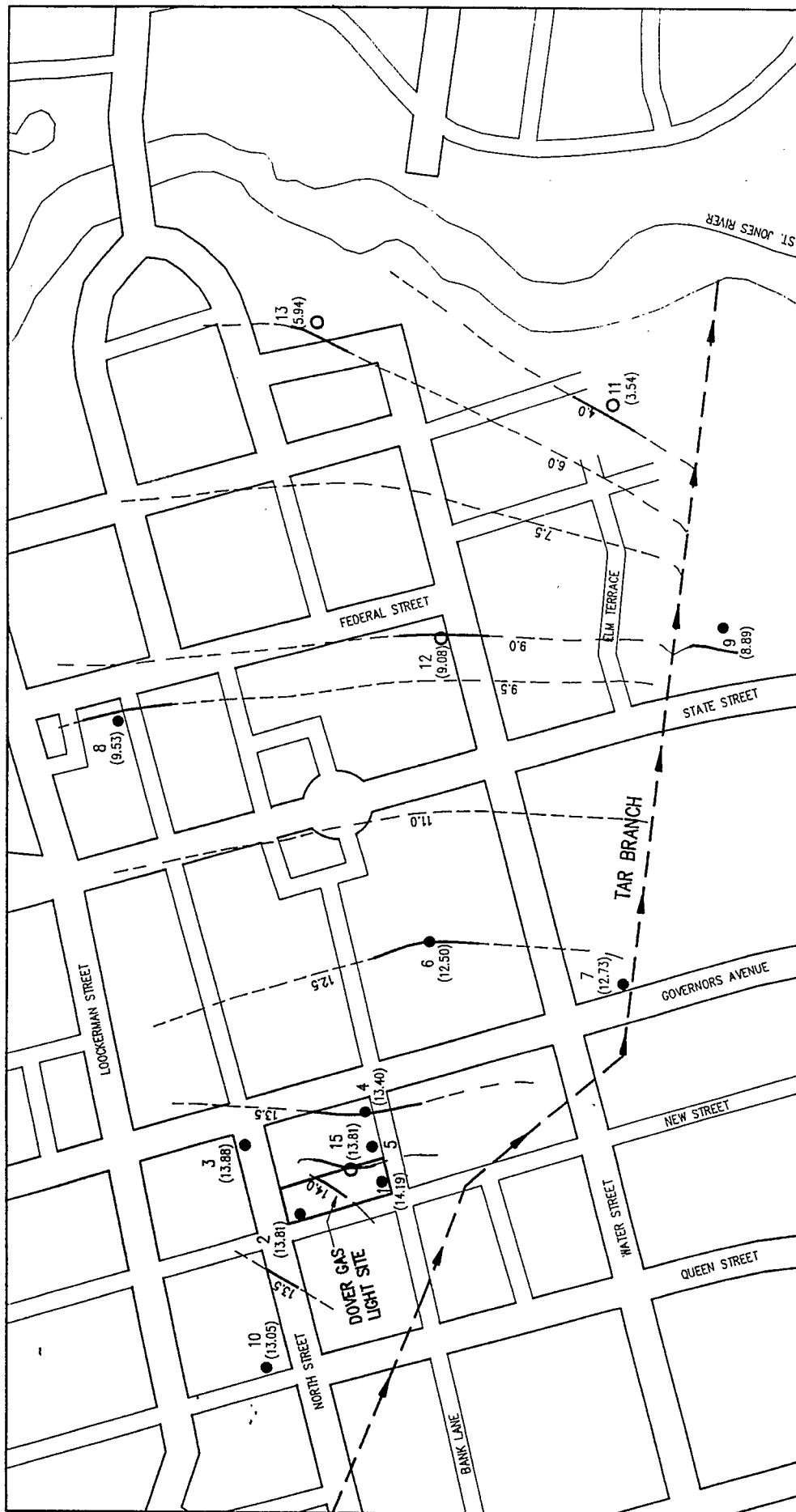
TABLE 3-3
FIELD MEASUREMENTS

MONITORING WELL NO.	SAMPLE pH:	CONDUCTIVITY:	TEMP. (CELSIUS)	PURGED VOLUME: (GALLONS)
MW1A	6.19	198	16.0	9
MW1B	5.03	198	16.7	20
MW1C	5.30	180	17.5	120
MW2A	6.22	700	19.7	6
MW2B	5.61	220	17.5	18
MW2C	N/A	N/A	N/A	45
MW3A	5.81	480	18.9	5
MW3B	5.40	186	17.2	18
MW3C	5.58	200	16.1	110
MW4A	N/A	N/A	N/A	8
MW4B	5.65	152	18.1	18
MW4C	6.15	140	17.6	170
MW5A	6.07	320	18.5	7
MW5B	4.91	180	17.9	18
MW5C	5.34	168	17.5	120
MW5D	7.65	360	16.3	32
MW6A1/2	6.74	510	17.7	55
MW6A	6.67	440	18.2	12
MW6B	4.85	162	18.1	90
MW6C	6.42	200	17.8	100
MW7A	6.29	140	21.2	48
MW7C	6.61	200	16.7	147
MW8A	6.17	540	18.4	50
MW9A	4.84	152	17.2	55
MW10A	6.04	320	18.3	19
MW10C	8.12	260	23.6	144
MW11A	N/A	N/A	N/A	50
MW11B	N/A	N/A	N/A	120
MW11C	N/A	N/A	N/A	120
MW11D	N/A	N/A	N/A	N/A
MW12A	6.08	420	18.5	18
MW12B	5.82	220	166	85
MW12C	N/A	N/A	N/A	300
MW13A	6.11	570	21.2	10
MW13B	7.05	450	18.2	90
MW15A/B	5.43	330	17.7	50

Note:

1. N/A - Information not available

FIGURE 4-1
GROUND-WATER ELEVATIONS IN "A" WELLS,
COLUMBIA AQUIFER, DOVER, DELAWARE



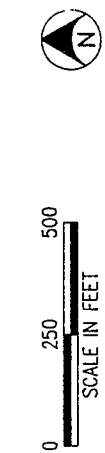
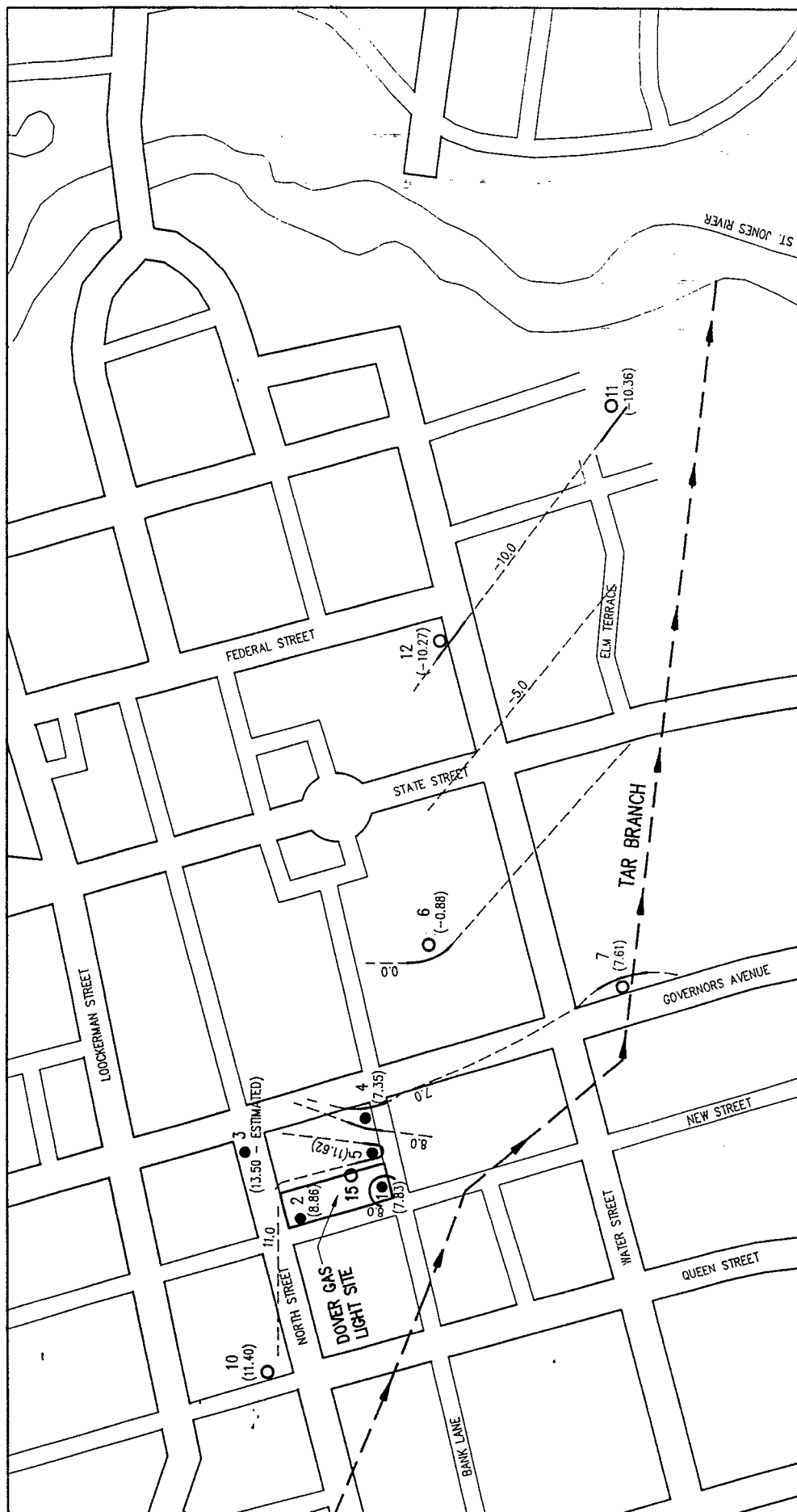
● EXISTING MONITORING WELL LOCATIONS
 ○ NEW MONITORING WELL LOCATIONS
 (13.81) WATER SURFACE ELEVATION MEASURED
 8/13 - 8/17/91, IN FEET ABOVE OR
 BELOW MEAN SEA LEVEL
 --- TARBOROUGH
 --- INFERRED CONTOURS OF WATER TABLE

0 250 500
 SCALE IN FEET



161\6527\107\654-1A.DWG DATE: 11-07-91

FIGURE 4-2
GROUND-WATER ELEVATIONS IN "C" WELLS,
DOVER, DELAWARE



TAR BRANCH
CONTOURS OF INFERRED
PIEZOMETRIC SURFACE

EXISTING MONITORING WELL LOCATIONS
PRIOR TO 1991
NEW MONITORING WELL LOCATIONS
WATER SURFACE ELEVATION MEASURED 11/1/91,
IN FEET ABOVE OR BELOW MEAN SEA LEVEL

161\6927\107\964-2.DWG DATE: 11-07-91

the 1985 Versar investigation. Moreover, there were no volatile organic compounds or PAHs detected in Well 10A (see Tables 5-1 through 5-4).

A semi-confining layer separates the Columbia and Frederica aquifers and the Frederica and Cheswold aquifers. The aquitards have a low hydraulic conductivity that inhibits flow and are composed of clays and silts that will tend to adsorb organic compounds. This impedes ground-water flow between the upper and lower aquifers. The piezometric head in the Frederica aquifer is almost always less than or similar to the head of water in the unconfined Columbia aquifer. This means there is a vertical gradient downward between the unconfined Columbia aquifer and the Frederica aquifer. There is also a vertical gradient downward from the Frederica to the Cheswold, as observed from the differences in head levels at Well Clusters 5 and 11. However, because of the confining layers, there is virtually no vertical flow between the aquifers. Further discussion of the effectiveness of the confining layers will be included in the final RI report where information regarding aquifer testing at and near the site will be provided and correlated with ground-water quality.

5.0 SAMPLING RESULTS

5.1 Ground Water

Ground-water samples were collected from thirty-six wells for analysis for VOCs, BNAs, and total and dissolved metals. Required QA/QC samples, such as trip blanks and field rinsate blanks, also were obtained. As requested and approved by the EPA, the City of Dover Well No. 9 was sampled instead of monitoring Well 11D. This was because the information from City of Dover Well No. 9 may be useful in the risk assessment. City of Dover Well No. 9 and Monitoring Well 11D are both screened in the Cheswold aquifer.

Thirteen volatile organic compounds were detected in one or more of the ground-water samples. Detected compounds are listed in Table 5-1. Of these, acetone is a common laboratory contaminant that was detected in 3 of the 4 trip blanks at low levels and, therefore, probably is not really present in the ground water. Seven of the detected compounds, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene (total), tetrachloroethane, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride are chlorinated compounds that are not related to the former gas manufacturing process on-site (see Section 1.5, Compounds of Concern). Vinyl chloride and the di- and tri-chlorinated compounds are common breakdown products of tetrachloroethane, or perchloroethene, a solvent used extensively in dry cleaning and degreasing operations. Because tetrachloroethane degrades readily in the environment, it is usually found in the greatest concentrations nearest the source of contamination. These

TABLE 5-1
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
VOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	91082054	91082051	91082065	91082048	91082075	91082063	91082064	91081472
Field Sample No.:	80031	80028	80025	80022	80018	80014	80015	80012
Date:	8/16/91	8/14/91	8/17/91	8/16/91	8/15/91	8/17/91	8/17/91	8/13/91
Location:	MW1A	MW2A	MW3A	MW4A	MW5A	MW6A	MW6A1/2	MW7A
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Dilution:	1.0	6.0	1.2	8.0	1.0	12.0	250.0	1.0
Parameter:								
Acetone	10 U	60 U	13 U	80 U	9.8 J	120 U	2500 U	10 U
Benzene	5.0 U	30 U	6.3 U	88	5.0 U	60 U	1250 U	5.0 U
1,1 -Dichloroethane	5.0 U	115	6.3 U	40 U	5.0 U	60 U	1250 U	5.0 U
1,1 -Dichloroethene	5.0 U	21 J	6.3 U	40 U	5.0 U	60 U	1250 U	5.0 U
1,2 -Dichloroethene (total)	5.0 U	750	6.8	40 U	5.0 U	1360	1250 U	5.0 U
Ethylbenzene	5.0 U	27 J	6.3 U	342	42	325	1620	5.0 U
Styrene	5.0 U	30 U	6.3 U	1110	69	60 U	1250 U	5.0 U
Tetrachloroethene	5.0 U	143	193	40 U	5.0 U	1900	47300	5.0 U
Toluene	5.0 U	30 U	6.3 U	1260	45	173	3450	5.0 U
1,1,1 -Trichloroethane	5.0 U	606	6.3 U	40 U	5.0 U	60 U	1250 U	5.0 U
Trichloroethene	5.0 U	26 J	6.7	40 U	5.0 U	406	1250 U	5.0 U
Vinyl Chloride	10 U	33 J	13 U	80 U	10 U	120 U	2500 U	10 U
Xylene (total)	5.0 U	30 U	6.3 U	1620	210	409	3280	5.0 U

Lab Sample No.:	91082062	91082061	91082043	91082039	91082037	91082068	91082070
Field Sample No.:	80011	80010	80008	80004	80001	80034	80036
Date:	8/17/91	8/17/91	8/14/91	8/16/91	8/15/91	8/17/91	8/17/91
Location:	MW8A	MW9A	MW10A	MW11A	MW12A	MW13A	MW15A/B
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Dilution:	1.0	1.0	1.0	1.0	4.0	1.0	8.0
Parameter:							
Acetone	10 U	10 U	10 U	10 U	40 U	10 U	80 U
Benzene	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	21 J
1,1 -Dichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	40 U
1,1 -Dichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	40 U
1,2 -Dichloroethene (total)	5.0 U	5.0 U	5.0 U	5.0 U	75	5.0 U	40 U
Ethylbenzene	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	598
Styrene	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	260
Tetrachloroethene	53	5.0 U	5.0 U	5.0 U	548	5.0 U	33 J
Toluene	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	254
1,1,1 -Trichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	40 U
Trichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	31	5.0 U	40 U
Vinyl Chloride	10 U	10 U	10 U	10 U	40 U	10 U	80 U
Xylene (total)	5.0 U	5.0 U	5.0 U	5.0 U	20 U	5.0 U	1190

Notes:

J - Compound was present but result was less than detection limit
B - Analyte was found in the laboratory blank
U - Compound was not detected

TABLE 5-1 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
VOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	91082055	91082052	91082066	91082049	91082045	91082044	91082040	91082038	91082069
Field Sample No.:	80032	80029	80026	80023	80019	80016	80005	80002	80035
Date:	8/16/91	8/14/91	8/17/91	8/16/91	8/14/91	8/15/91	8/16/91	8/15/91	8/17/91
Location:	MW1B	MW2B	MW3B	MW4B	MW5B	MW6B	MW11B	MW12B	MW13B
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Dilution:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0

Parameter:

Acetone	10 U	10 U	10 U	10 U	10 U	8.2 J	5.1 J	31	16
Benzene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	119
1,1 -Dichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	5.0 U
1,1 -Dichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	5.0 U
1,2 -Dichloroethene (total)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	18	5.0 U
Ethylbenzene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	31
Styrene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	5.0 U
Tetrachloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	363	4.5 J
Toluene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	26
1,1,1 -Trichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	5.0 U
Trichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	8.7 J	5.0 U
Vinyl Chloride	10 U	10 U	10 U	10 U	10 U	10 U	10 U	25 U	10 U
Xylene (total)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	13 U	229

Lab Sample No.:	91082056	91082053	91082068	91082050	91082046	91082074	91081471	91081473	91082041	91082057
Field Sample No.:	80033	80030	80027	80024	80020	80017	80013	80009	80006	80107
Date:	8/16/91	8/14/91	8/17/91	8/16/91	8/14/91	8/15/91	8/13/91	8/13/91	8/16/91	8/14/91
Location:	MW1C	MW2C	MW3C	MW4C	MW5C	MW6C	MW7C	MW10C	MW11C	MW12C
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Dilution:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Parameter:

Acetone	10 U	10 U	10 U	10 U	10 U	5.5 J	10 U	10 U	10 U	10 U
Benzene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	2.3 J
1,1 -Dichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1 -Dichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2 -Dichloroethene (total)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	6.2
Ethylbenzene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Styrene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.6	5.0 U	5.0 U	5.0 U	5.0 U
Toluene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,1 -Trichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Trichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Vinyl Chloride	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Xylene (total)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

Notes:

J - Compound was present but result was less than detection limit

B - Analyte was found in the laboratory blank

U - Compound was not detected

TABLE 5-1 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
VOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	91082047	91082042	91082060	91082058	91082059	91082073	91082071	91081474	91082072
Field Sample No.:	80021	80007	80116	80110	80113	80119	80122	80106	80123
Date:	8/14/91	8/16/91	8/16/91	8/15/91	8/5/91	8/17/91	8/17/91	8/13/91	8/17/91
Location:	MW5D	MW11D	MW11E*	Bailer Rinse	Dup. of MW6B	Trip Blank	Trip Blank	Trip Blank	Field Blank
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Dilution:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Parameter:									
Acetone	10 U	10 U	10 U	10 U	10 U	9.3 J	10 U	13	6.8 J
Benzene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1 -Dichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1 -Dichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2 -Dichloroethene (total)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Ethylbenzene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Styrene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Toluene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,1 -Trichloroethane	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Trichloroethene	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Vinyl Chloride	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Xylene (total)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

Notes:

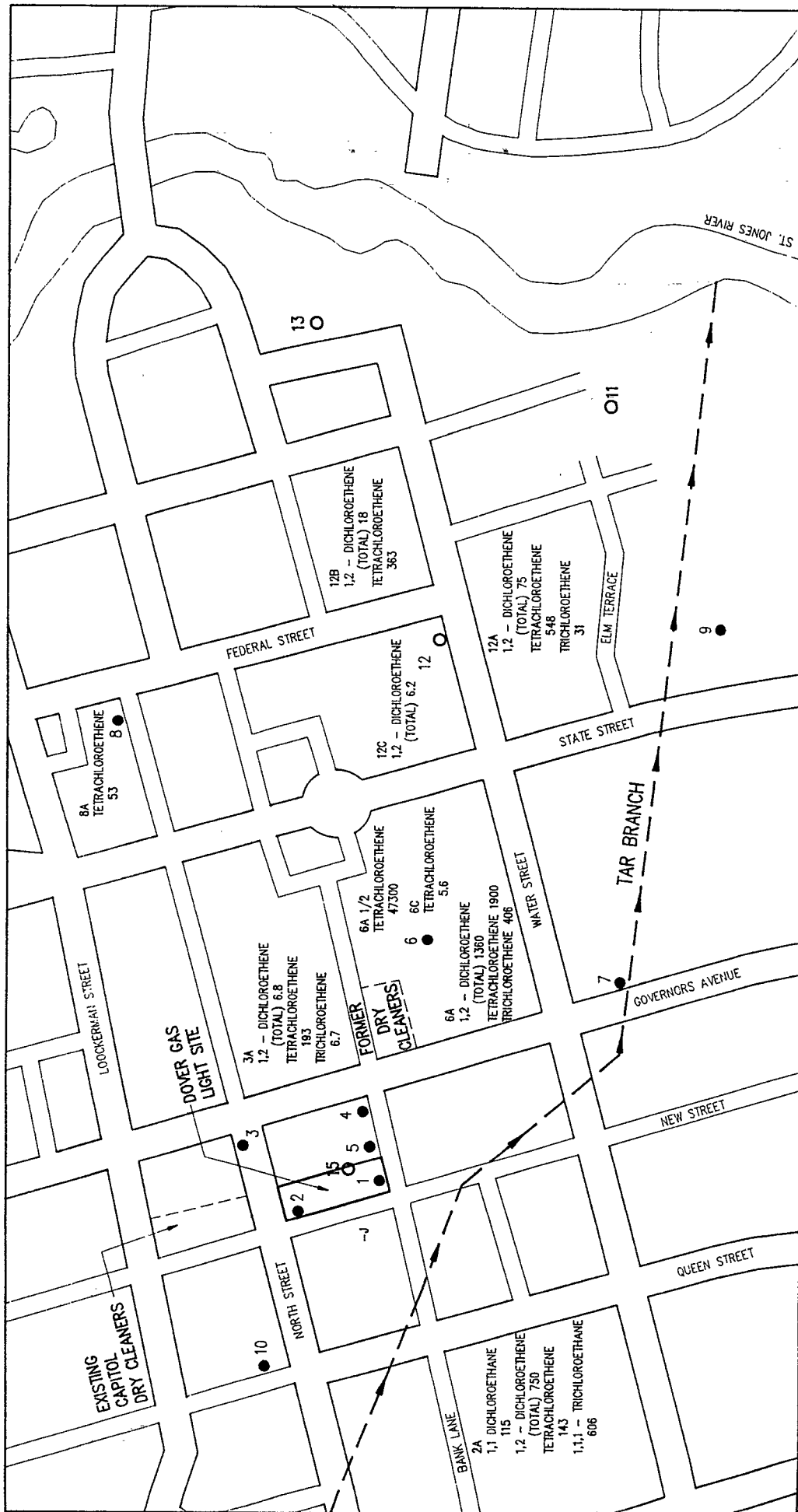
- J - Compound was present but result was less than detection limit
- B - Analyte was found in the laboratory blank
- U - Compound was not detected
- * - MW11E is a duplicate of MW11D which was taken from City Well #9

chlorinated compounds were found in samples from Wells 2A, 3A, 6A, 6A1/2, 6C, 12A, 12B, and 12C. All of these wells are near or immediately downgradient of existing or former dry cleaning activities. Figure 5-1 presents the total chlorinated organic compounds detected in the "A", "B", and "C" wells.

The remaining five volatile organic compounds, benzene, toluene, ethylbenzene, styrene, and total xylenes, are compounds that have been found on-site. In addition, BTEX is a major component of gasoline and other light petroleum products. These compounds were found in samples from Wells 4A, 5A, 6A, 6A1/2, 13B, and 15A/B. Wells 4A, 5A, and 15A/B are located on-site or immediately downgradient of the site. Wells 6A and 6A1/2 are located in the first off-site well cluster downgradient and approximately 640 feet southeast from the site. Well 13B is in the well cluster farthest east from the site. No site-related compounds were found in Wells 12A, 12B, or 13A, which are located between the site and Well 13B. Also, no volatile organic compounds were detected in Well 10A, which is located northwest of the site. Figures 5-2 and 5-3 show the detectable total BTEX and semivolatile concentrations in the "A" and "B" series wells, respectively, except for bis(2-ethylhexyl)phthalate, which was omitted because it is a common laboratory contaminant. No figure was drawn for the "C" or "D" series wells, screened in the Frederica and Cheswold aquifers, because no BTEX or semivolatile compounds were detected in any of those wells at concentrations above method detection limits, with the exception of 12C, where benzene was detected at a 2.3 µg/l. The 2.3 µg/l concentration is below the method detection limit and, therefore, this concentration is of questionable validity. It is notable that no styrene was detected in any wells other than 4A, 5A, and 15A/B, which are all either on or immediately adjacent to the site.

Eleven semi-volatile organic compounds were detected in one or more of the wells. Detected compounds are listed in Table 5-2. These compounds were found in samples from Wells 2A, 4A, 5A, 6A, 6A1/2, 13B, and 15A/B. Wells 2A, 4A, 5A, and 15A/B are located on-site or immediately downgradient of the site. Wells 6A and 6A1/2 are located in the first off-site well cluster downgradient and approximately 640 feet southeast from the site. Well 13B is in the well cluster farthest east from the site. No site-related compounds were found in Wells 12A, 12B, or 13A, which are located between the site and Well 13B. Napthalene, in a low concentration, was the only PAH detected in Well 2A, which is in the northwest portion of the site. However, no PAHs were detected in Well 10A, which is located northwest of the site. Of these, bis(2-ethylhexyl)phthalate is a common laboratory contaminant and a ubiquitous plastic additive. The other ten compounds are PAHs that have been identified at the site and also are common constituents of fuels and other petroleum hydrocarbon products (Versar, 1991b). The PAHs that were detected are the more soluble ones, such as naphthalene and phenolic compounds. These compounds are several orders of magnitude less mobile than BTEX and

FIGURE 5-1
TOTAL CHLORINATED ORGANIC COMPOUNDS
DOVER, DELAWARE



NOTE: VALUES SHOWN DO NOT INCLUDE SAMPLE RESULTS WITH A "J" OR "U" FOOTNOTE.

NOTE: CONCENTRATIONS IN UG/L

EXISTING MONITORING WELL/WELL CLUSTER PRIOR TO 1991

NEW MONITORING WELL/WELL CLUSTER

TAR BRANCH

SCALE IN FEET

0 250 500

ST. JONES RIVER

FEDERAL STREET

STATE STREET

GOVERNORS AVENUE

NEW STREET

QUEEN STREET

BANK LANE

LOCKERMAN STREET

DOVER GAS LIGHT SITE

FORMER DRY CLEANERS

ELM TERRACE

FIGURE 5-2
TOTAL B.T.E.X. AND TOTAL SEMIVOLATILE ORGANIC COMPOUNDS FOR "A" WELLS
DOVER, DELAWARE

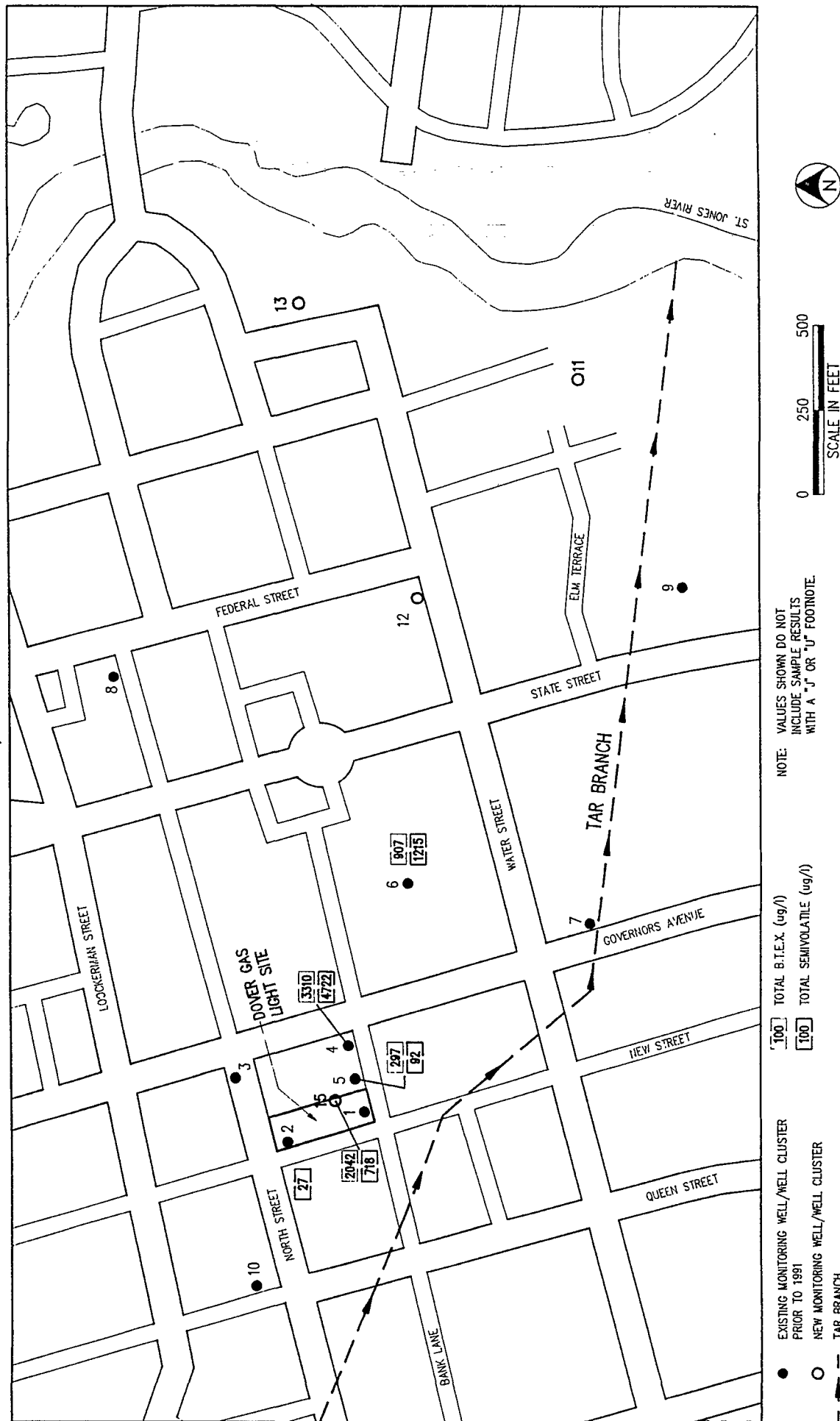


FIGURE 5-3
TOTAL B.T.E.X. AND TOTAL SEMIVOLATILE ORGANIC COMPOUNDS FOR "B" WELLS
DOVER, DELAWARE

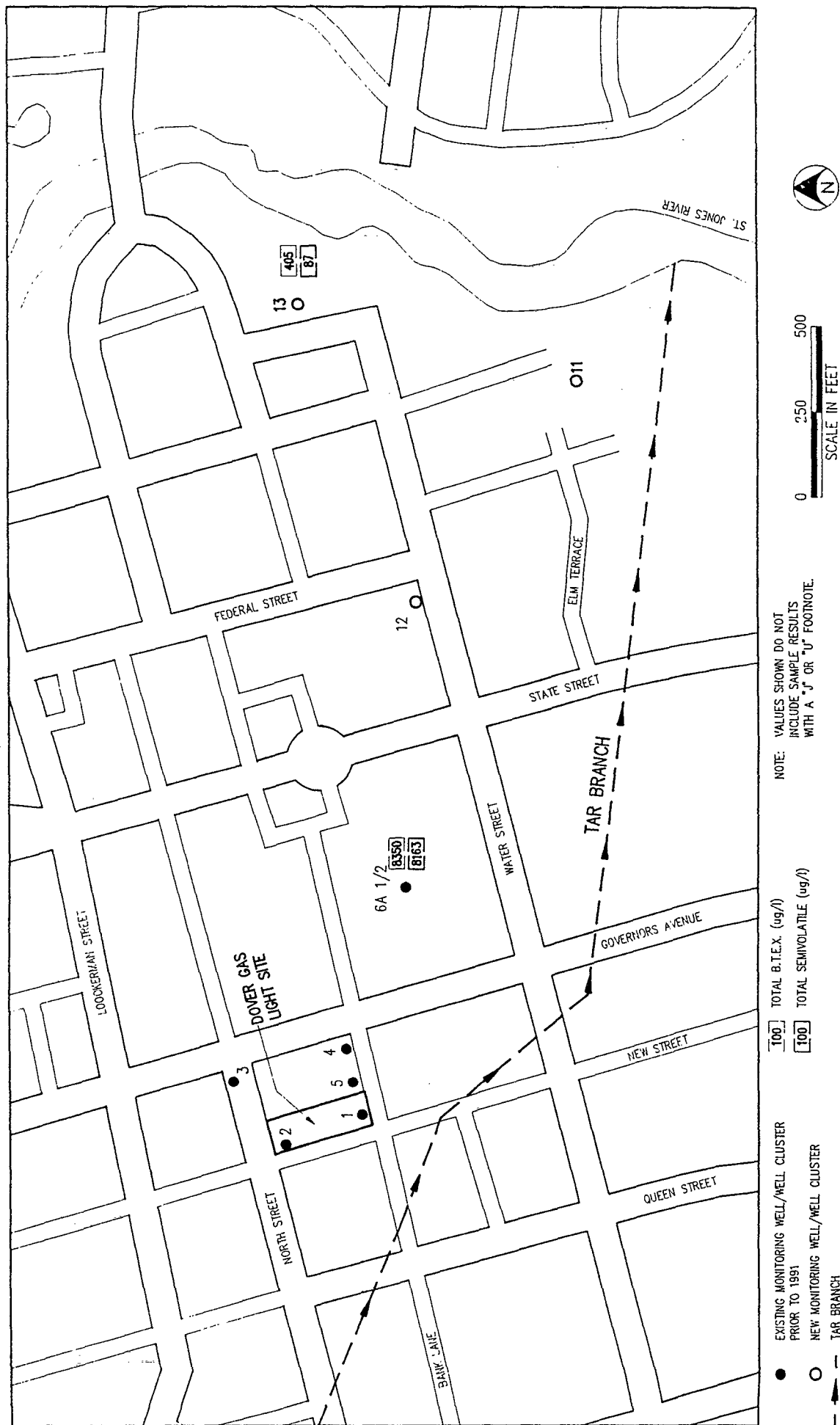


TABLE 5-2
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
SEMIVOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	91082002	91082005	91082031	91082031	91082008	91082011	91082029	91082030	91081476
Field Sample No.:	80103	80100	80097-RE	80097	80094	80090	80086	80087	80085
Date:	8/16/91	8/14/91	8/17/91	8/17/91	8/16/91	8/14/91	8/17/91	8/17/91	8/13/91
Location:	MW1A	MW2A	MW3A	MW3A	MW4A	MW5A	MW6A	MW6A1/2	MW7A
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

MS/MSD

Acenaphthene	10 U	10 U	12 U	10 U	150 U	10 U	40 U	250 U	10 U
Acenaphthylene	10 U	10 U	12 U	10 U	336	10 U	98	445	10 U
Anthracene	10 U	10 U	12 U	10 U	150 U	10 U	30 J	250 U	10 U
bis(2-Ethylhexyl)Phthalate	10 U	10 U	12 U	10 U	150 U	10 U	40 U	250 U	19
Fluoranthene	10 U	10 U	12 U	10 U	150 U	10 U	30 J	250 U	10 U
Fluorene	10 U	10 U	12 U	10 U	150 U	10 U	53	250 U	10 U
2-Methylnaphthalene	10 U	10 U	12 U	10 U	396	10 U	123	990	10 U
4-Methylphenol	10 U	10 U	12 U	10 U	150 U	10 U	40 U	250 U	10 U
Naphthalene	10 U	27	12 U	10 U	3990	92	744	6350	10 U
Phenanthrene	10 U	10 U	12 U	10 U	89 J	10 U	138	378	10 U
Pyrene	10 U	10 U	12 U	10 U	150 U	10 U	59	167 J	10 U

Lab Sample No.:	91082028	91082027	91082018	91082019	91082022	91082026	91082035	91082035
Field Sample No.:	80083	80082	80080	80076	80073	80079	80121	80121-RE
Date:	8/17/91	8/17/91	8/14/91	8/16/91	8/16/91	8/17/91	8/17/91	8/17/91
Location:	MW8A	MW9A	MW10A	MW11A	MW12A	MW13A	MW15A/B	MW15A/B
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Acenaphthene	10 U	10 U	10 U	10 U	10 U	10 U	17	13 U
Acenaphthylene	10 U	10 U	10 U	10 U	10 U	10 U	55	13 U
Anthracene	10 U	10 U	10 U	10 U	10 U	10 U	6.4 J	13 U
bis(2-Ethylhexyl)Phthalate	10 U	10 U	10 U	10 U	10 U	10 U	13 U	13 U
Fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U	7.3 J	13 U
Fluorene	10 U	10 U	10 U	10 U	10 U	10 U	22	13 U
2-Methylnaphthalene	10 U	10 U	10 U	10 U	10 U	10 U	204	13 U
4-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U	13 U	13 U
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U	398	13 U
Phenanthrene	10 U	10 U	10 U	10 U	10 U	10 U	22	13 U
Pyrene	10 U	10 U	10 U	10 U	10 U	10 U	13 J	13 U

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

MS/MSD - Matrix spike and Matrix spike Duplicate sample

RE - Reanalyzed sample due to noncompliant protocol

Both the original and the reanalyzed appear

TABLE 5-2 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
SEMIVOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	91082003	91082006	91082032	91082009	91082012	91082015	91082020	91082023	91082034	91082004
Field Sample No.:	80103	80101	80098	80095	80091	80088	80077	80074	80117	80104
Date:	8/16/91	8/14/91	8/17/91	8/16/91	8/14/91	8/15/91	8/16/91	8/15/91	8/17/91	8/16/91
Location:	MW1B	MW2B	MW3B	MW4B	MW5B	MW6B	MW11B	MW12B	MW13B	MW1C
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Acenaphthene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	4.1 J	10 U
Acenaphthylene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	4.4 J	10 U
Anthracene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)Phthalate	10 U	10 U	10 U	10 U	10 U	10 U	15	21	10 U	10 U
Fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Fluorene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	87	10 U
Phenanthrene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Pyrene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U

Lab Sample No.:	91082007	91082033	91082010	91082013	91082016	91081475	91081477	91082021	91082024
Field Sample No.:	80102	80099	80096	80092	80089	80085	80081	80078	80074
Date:	8/14/91	8/17/91	8/16/91	8/14/91	8/15/91	8/13/91	8/13/91	8/16/91	8/15/91
Location:	MW2C	MW3C	MW4C	MW5C	MW6C	MW7C	MW10C	MW11C	MW12C
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Acenaphthene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Anthracene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)Phthalate	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Fluorene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Phenanthrene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Pyrene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U

Notes:

J- Compound was present but result was less than detection limit
B- Analyte was found in the laboratory blank
U- Compound was not detected

TABLE 5-2 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
SEMIVOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	91082014	91082025	91082017	91082036	70652	70653
Field Sample No.:	80093	80111	80114	80124	70652	70653
Date:	8/14/91	8/15/91	8/15/91	8/17/91	7/12/91	7/12/91
Location:	MW5D	Bailer Rinse	Dup. of MW6B	Field Blank	City Well Number 9	Field Duplicate
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Parameter:						
Acenaphthene	10 U	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10 U	10 U	10 U	10 U	10 U	10 U
Anthracene	10 U	10 U	10 U	10 U	10 U	10 U
bis(2-Ethylhexyl)Phthalate	10 U	10 U	10 U	10 U	10 U	10 U
Fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U
Fluorene	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylnaphthalene	10 U	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U
Phenanthrene	10 U	10 U	10 U	10 U	10 U	10 U
Pyrene	10 U	10 U	10 U	10 U	10 U	10 U

Note:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

*- These samples were the Matrix spike and Matrix spike Duplicate

other volatile organic compounds, because they have higher molecular weights and higher Koc values (see Table 1-1).

For comparative purposes, metal analyses were performed on two separate samples from each well, one for dissolved concentrations (field filtered) and the other for total concentrations (non-field filtered). Several metals were detected in the samples for total metals analysis. Because sediments were not filtered from these samples in the field, the concentrations of the detected metals were higher than in the dissolved metals samples. Metals with the highest concentrations detected in both sets of samples included calcium, iron, magnesium, potassium, and sodium, all of which are indicators and components of water hardness. The Columbia aquifer is known to contain elevated levels of iron (Versar, 1991b; Woodruff, 1972). Most of these metals were not detected above the method detection limits in the dissolved metals analyses, and no elevated levels of these metals were detected in the filtered well water samples. This difference in detected concentrations between the two sets of samples suggests that the elevated total metals concentrations are the result of the leaching out of metals from sediments contained within the samples by the acid used as a preservative. It must be noted that the dissolved metal results indicate that none of the analyzed metals were present at concentrations above the maximum contaminant levels (MCLs). Total metals analysis data are provided in Table 5-3. Dissolved metals analysis data are presented in Table 5-4.

5.2 Soils

Soil samples were collected from monitoring well borings as required, when field observations indicated odors, staining, or detection of volatile organic compounds by a PID. Six soil samples from three well locations, (6C, 7C, and 13B) were collected and analyzed for VOCs, BNAs, and total metals. The results are shown in Tables 5-5, 5-6, and 5-7, respectively. One sample from Well 7C was not analyzed for total metals because of insufficient sample volume.

Four volatile organic compounds were detected in one or more of the soil samples. However, none of these compounds are related to the former gas manufacturing process on-site (Versar, 1991b). Acetone and methylene chloride are common laboratory contaminants. Methylene chloride also was detected in the laboratory blank corresponding to the Well 7C sample. Carbon disulfide is related to degradation of humic materials in soil and water, and is associated with the manufacture of carbon tetrachloride and other solvents (Hawley, 1981). Tetrachloroethane and carbon disulfide were detected in one soil sample from 45 to 47 feet BGS in Well 6C. These compounds are most likely related to the dry cleaning establishment that was located immediately upgradient of Well Cluster 6.

TABLE 5-3
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
TOTAL METALS

Lab Sample No.:	59132	59129	59181	59126	59122	59179	59180	58621	59178
Field Sample No.:	80067	80064	80061	80058	80054	80050	80051	80048	80047
Date:	8/16/91	8/14/91	8/17/91	8/16/91	8/15/91	8/17/91	8/17/91	8/13/91	8/17/91
Location:	MW1A	MW2A	MW3A	MW4A	MW5A	MW6A	MW6A1/2	MW7A	MW8A
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	2480	10700	44400	432	559	12200	275	5700	20100
Antimony	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	17.0 B
Arsenic	1.0 U	2.2 B	1.8 B	1.5 B	1.0 U	1.5 B	13.4	13.9	4.2 B
Barium	131 B	147 B	414	398	165 B	297	456	79.3 B	129 B
Beryllium	1.4 B	1.6 B	3.1 B	1.0 U	1.0 U	1.2 B	1.0 U	1.0 U	1.8 B
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	11100	71500	46700	35200	24100	31000	37100	8140	46400
Chromium	6.3 B	10.8	40.9	2.0 U	2.0 U	27.2	2.0 B	30.7	57.1
Cobalt	2.9 B	11.7 B	53.0	11.6 B	3.7 B	8.8 B	2.4 B	5.6 B	14.2 B
Copper	2.4 B	39.7	63.4	1.0 U	4.5 B	11.0 B	7.7 B	17.5 B	28.7
Iron	8970	60200	63300	24400	6900	50500	50100	31800	49400
Lead	5.9	39.2	65.2	1.2 B	2.0 B	15.7	2.4 B	30.3	13.5
Magnesium	5050	7830	14400	9410	8110	10900	7790	3530 B	14300
Manganese	323	2650	12000	2410	838	1470	1980	69.6	599
Mercury	0.28	0.21	0.50	0.20 U	0.20 U	0.21	0.20 U	0.20 U	1.0
Nickel	10.0 U	10.0 U	29.3 B	10.0 U	10.0 U	10.0 U	10.0 U	10.5 B	10.6 B
Potassium	4470 B	11500	16500	8380	5900	6610	14700	2470 B	16000
Selenium	1.0 U	1.0 U	2.6 B	1.0 B	1.0 U	1.0 U	1.0 U	6.2	2.8 B
Silver	2.0 U	2.6 B	4.0 B	2.0 U	2.0 U	2.1 B	3.6 B	3.0 B	2.0 B
Sodium	8460	31300	28900	16100	14700	54100	51500	10200	36100
Thallium	1.0 B	1.7 B	1.0 U	1.4 B	1.0 U	1.0 U	1.0 U	1.8 B	1.0 U
Vanadium	11.2 B	25.3 B	85.2	2.0 U	2.7 B	34.0 B	10.2 B	107	67.7
Zinc	22.8	48.3	114	14.8 B	11.4 B	42.7	31.6	40.8	64.1

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-3 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
TOTAL METALS

Lab Sample No.:	59177	59119	59115	59113	59184	59186	59133	59103	59182
Field Sample No.:	80046	80044	80040	80037	80071	80072	80068	80065	80062
Date:	8/17/91	8/14/91	8/16/91	8/15/91	8/17/91	8/17/91	8/16/91	8/14/91	8/17/91
Location:	MW9A	MW10A	MW11A	MW12A	MW13A	MW15A/B	MW1B	MW2B	MW3B
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	15900	76.4 B	2590	2000	11400	141000	291	345	603
Antimony	15.2 B	10.0 U	10.0 U	10.0 U	10.0 U	27.6 B	10.0 U	10.0 U	10.0 U
Arsenic	82.5	1.0 U	6.0 B	1.7 B	1.4 B	1.0 U	1.0 U	1.0 U	1.0 U
Barium	233	64.0 B	93.6 B	102 B	84.7 B	931	154 B	84.0 B	14.7 B
Beryllium	1.1 B	1.0 U	1.0 U	1.0 U	1.0 U	20.2	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	8080	26100	6150	31000	54200	37600	12900	15800	4940 B
Chromium	98.5	3.5 B	12.6	11.6	33.3	213	8.0 B	4.4 B	2.0 U
Cobalt	5.9 B	2.0 U	4.0 B	2.3 B	5.4 B	103	2.0 U	2.0 U	2.0 U
Copper	32.0	1.0 U	11.0 B	5.4 B	7.2 B	103	4.8 B	1.0 U	4.0 B
Iron	88200	159	5900	13000	31800	342000	1050	2390	1750
Lead	20.5	1.6 B	4.0 B	1.8 B	8.1	276	9.8	1.6 B	11.5
Magnesium	6540	11600	3410 B	9660	13600	14400	6310	7930	1530 B
Manganese	140	7.0 B	22.4	40.1	132	9340	19.6	14.9 B	30.3
Mercury	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.61	0.20 U	0.20 U	0.33
Nickel	20.8 B	10.0 U	10.4 B	10.0 U	10.0 U	109	10.0 U	10.0 U	10.0 U
Potassium	3980 B	2360 B	4360 B	13300	7730	9990	2770 B	4650 B	2660 B
Selenium	6.5	3.2 B	1.5 B	1.8 B	4.9 B	1.0 U	1.0 U	1.5 B	1.0 U
Silver	4.4 B	2.0 U	2.0 U	2.0 U	2.0 U	16.0	2.0 U	2.0 U	2.0 U
Sodium	7240	15600	12000	28500	35400	17200	8030	10800	26500
Thallium	1.0 U	1.0 U	1.0 B	1.0 U	1.0 U	2.2 B	1.0 U	1.0 U	1.0 U
Vanadium	120	2.0 U	12.5 B	12.6 B	34.5 B	428	2.4 B	3.1 B	2.0 U
Zinc	51.3	2.8 B	42.0	18.7 B	25.2	381	17.6 B	12.5 B	13.7 B

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-3 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
TOTAL METALS

Lab Sample No.:	59127	59123	59120	59118	59113	59185	59134	59131	59183
Field Sample No.:	80059	80055	80052	80043	80037	80071	80069	80066	80063
Date:	8/16/91	8/14/91	8/15/91	8/16/91	8/15/91	8/17/91	8/16/91	8/14/91	8/17/91
Location:	MW4B	MW5B	MW6B	MW11B	MW12B	MW13B	MW1C	MW2C	MW3C
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	1440	1050	670	303	2000	3680	311	869	1690
Antimony	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Arsenic	1.0 U	1.0 U	1.2 B	1.2 B	1.7 B	3.4 B	1.0 U	1.0 U	1.0 U
Barium	92.8 B	105 B	66.4 B	58.4 B	102 B	91.6 B	42.7 B	39.9 B	48.0 B
Beryllium	1.0 U	1.0 U	1.6 U	1.0 U	1.0 U	1.4 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	10900	11300	11200	10400	31000	27400	23900	9190	9890
Chromium	6.1 B	6.1 B	3.4 B	3.2 B	11.6	15.1	4.4 B	5.1 B	13.6
Cobalt	2.0 U	2.0 U	2.0 U	2.0 U	2.3 B	2.0 U	2.0 U	2.0 U	2.0 U
Copper	2.7 B	6.0 B	3.8 B	14.1 B	5.4 B	12.0 B	5.2 B	10.4 B	46.6
Iron	6590	4290	2240	1310	13000	8190	1860	3430	5920
Lead	4.2 B	1.9 B	5.7	4.8 B	1.8 B	12.6	2.6 B	17.5	97.2
Magnesium	4410 B	4920 B	4140 B	5700	9660	6680	4550 B	2450 B	3020 B
Manganese	40.0	31.2	23.4	39.1	40.1	774	97.5	117	74.8
Mercury	0.20 U	0.21	0.20 U	0.23	0.20 U	0.20 U	0.20 U	0.20 U	0.33
Nickel	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 B	12.5 B
Potassium	6200	4740 B	2070 B	8900	13300	14900	1140 B	3800 B	3380 B
Selenium	1.0 U	1.0 U	1.0 U	1.5 B	1.8 B	1.4 B	1.0 U	1.0 U	1.0 U
Silver	2.0 U	2.0 U	1.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Sodium	6400	6970	8480	17700	28500	65400	5470	8650	23400
Thallium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vanadium	8.4 B	5.6 B	2.0 U	2.0 U	12.6 B	10.0 B	2.0 U	2.8 B	5.7 B
Zinc	18.3 B	17.5 B	27.6	32.9	18.7 B	48.7	11.2 B	34.4	219

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-3 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
TOTAL METALS

Lab Sample No.:	59128	59124	59121	58622	58620	59116	59134	59125	59117
Field Sample No.:	80060	80056	80053	80049	80045	80041	80069	80045	80042
Date:	8/16/91	8/14/91	8/15/91	8/13/91	8/13/91	8/16/91	8/16/91	8/14/91	8/16/91
Location:	MW4C	MW5C	MW6C	MW7C	MW10C	MW11C	MW12C	MW5D	MW11D
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	1490	206	5830	720	114 B	652	115 B	316	10.0 U
Antimony	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Arsenic	1.8 B	1.0 U	14.7	2.5 B	1.0 U	3.3 B	1.0 U	1.0 U	1.0 U
Barium	53.6 B	54.7 B	96.6 B	73.1 B	45.0 B	44.2 B	77.5 B	9.8 B	1.6 B
Beryllium	1.1 B	1.0 U	1.1 B	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	4.9 B	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	12700	11400	19600	30200	18600	24000	24200	54800	30300
Chromium	5.2 B	3.6 B	44.0	5.6 B	3.5 B	2.3 B	9.1 B	2.0 U	2.0 U
Cobalt	2.9 B	2.0 U	7.1 B	3.5 B	2.3 B	2.0 U	2.0 U	2.0 U	2.0 U
Copper	3.8 B	4.9 B	20.3 B	13.2 B	7.4 B	8.2 B	9.1 B	1.0 U	3.1 B
Iron	31000	1070	33100	4690	7830	4180	6310	531	13.4 B
Lead	7.8	2.1 B	14.0	2.5 B	1.1 B	3.1 B	14.2	3.8 B	1.0 U
Magnesium	4510 B	4170 B	5050	4570 B	3450 B	4700 B	5690	7770	4570 B
Manganese	670	21.5	188	231	222	118	211	444	70.5
Mercury	0.20	0.20	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	2.0 U	0.20 U
Nickel	10.0 U	10.0 U	29.4 B	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Potassium	3770 B	4130 B	30700	18900	17200	1790 B	21400	3040 B	2230 B
Selenium	1.0 U	1.0 U	3.0 B	4.0 B	2.8 B	1.0 B	1.0 U	1.0 U	1.0 U
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Sodium	6100	8240	20100	14200	14200	7080	22700	5300	14000
Thallium	1.2 B	1.0 U	1.2 B	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vanadium	5.0 B	2.1 B	34.4 B	2.9 B	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Zinc	16.1 B	12.2 B	240	19.3 B	9.7 B	22.6	13.5 B	30.0	5.6 B

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-3 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
TOTAL METALS

Lab Sample No.:	59136	59137	59138	59187
Field Sample No.:	80112	80115	80118	80125
Date:	Bailer	8/15/91	8/15/91	Field
Location:	Rinsate	Dup of MW6B	MW11E*	Blank
Units:	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	13.7 B	649	35.5 B	11.3 B
Antimony	10.0 U	10.0 U	10.0 U	10.0 U
Arsenic	1.0 U	1.1 B	1.0 U	1.0 U
Barium	1.2 B	72.0 B	2.5 B	1.0 U
Beryllium	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	58.6 B	11100	32600	5.0 U
Chromium	2.0 U	4.5 B	2.1 B	2.0 U
Cobalt	2.0 U	3.0 B	2.0 U	2.0 U
Copper	4.5 B	8.4 B	1.4 B	1.0 U
Iron	5.0 U	3090	55.3 B	5.0 U
Lead	1.0 U	5.9	1.0 U	1.0 U
Magnesium	50.0 U	4100 B	5090	50.0 U
Manganese	1.0 U	25.9	76.6	1.0 U
Mercury	0.20	0.44	0.28	0.20 U
Nickel	10.0 U	10.0 U	10.0 U	10.0 U
Potassium	913 B	3410 B	3740 B	400 U
Selenium	1.0 U	1.0 U	1.0 U	1.0 U
Silver	2.0 U	2.4 B	2.0 U	2.0 U
Sodium	150 B	7340	12500	50.0 U
Thallium	1.0 U	1.0 U	1.0 U	1.0 U
Vanadium	2.0 U	3.4 B	2.0 U	2.0 U
Zinc	9.8 B	27.4	4.0 B	2.0 U

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

*- MW11E was a duplicate of MW11D which was taken from City Well #9

TABLE 5-4
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
DISSOLVED METALS

Lab Sample No.:	59106	59103	59170	59100	59096	59168	59169
Field Sample No.:	80067	80064	80061	80058	80054	80050	80051
Date:	8/16/91	8/14/91	8/17/91	8/16/91	8/15/91	8/19/91	8/17/91
Location:	MW1A	MW2A	MW3A	MW4A	MW5A	MW6A	MW6A1/2
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	17.7 B	61.3 B	33.4 B	10.0 U	16.5 B	231	36.4 B
Arsenic	1.0 U	1.0 U	1.0 U	1.0 U	1.2 B	1.0 U	1.0 U
Barium	102 B	82.9 B	76.2 B	360	148 B	168 B	385
Beryllium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	10500	71300	47800	35000	24900	30800	41200
Chromium	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Cobalt	2.0 U	4.9 B	2.0 U	7.6 B	2.1 B	3.7 B	2.0 U
Copper	1.0 U	1.0 B	1.0 U	1.2 B	1.0 U	1.0 U	1.0 U
Iron	17.5 B	17700	29.0 B	360	1840	3090	1540
Lead	1.0 U	1.0 U	1.2 B	1.6 B	1.0 U	1.1 B	1.0 U
Magnesium	4560 B	7190	12500	9210	8240	10200	8690
Manganese	18.1	2420	4.6 B	2340	831	1390	2110
Mercury	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Potassium	2010 B	9360	14500	7030	6030	5460	15100
Selenium	1.0 U	1.0 U	2.1 B	1.4 B	1.0 U	1.0 U	1.0 U
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Sodium	8700	35100	31400	16400	16000	53800	56500
Thallium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vanadium	1.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Zinc	17.9 B	26.2	3.1 B	4.4 B	10.7 B	18.5 B	17.9 B

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-4 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
DISSOLVED METALS

Lab Sample No.:	58618	59167	59166	59093	59089	59087	59173	59175
Field Sample No.:	80048	80046	80046	80044	80040	80037	80070	80072
Date:	8/13/91	8/17/91	8/17/91	8/14/91	8/17/91	8/15/91	8/17/91	8/17/91
Location:	MW7A	MW8A	MW9A	MW10A	MW11A	MW12A	MW13A	MW15A/B
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	34.8 B	80.0 B	86.5 B	10.0 U	207	115 B	157 B	62.9 B
Arsenic	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2.2 B	1.0 U	1.0 U
Barium	53.1 B	58.6 B	126 B	68.2 B	84.1 B	93.1 B	42.8 B	75.9 B
Beryllium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	7960	47200	7270	27400	6360	31600	59300	36700
Chromium	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Cobalt	2.0 U	2.1 B	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	7.2 B
Copper	11.4 B	1.2 B	1.0 U	1.0 U	1.0 U	23.7 B	1.0 U	1.0 U
Iron	5.1 B	143	293	5.0 U	248	718	291	209
Lead	1.6 B	2.1 B	1.2 B	1.2 B	1.0 U	1.0 B	1.0 U	1.0 U
Magnesium	3140 B	13400	4690 B	12200	3360 B	9790	14400	9540
Manganese	21.0	11.6 B	96	1.0 U	18.5	9.5 B	9.3 B	5340
Mercury	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Potassium	3010 B	15300	1700 B	2590 B	3640 B	14700	5370	2420 B
Selenium	3.2 B	2.1 B	1.0 U	1.9 B	1.3 B	2.4 B	4.3 B	1.1 B
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Sodium	10600	36400	7310	16400	11600	32000	37400	19500
Thallium	1.1 B	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vanadium	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Zinc	32.2	7.6 B	26.2	3.8 B	41.2	9.0 B	5.5 B	13.8 B

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-4 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
DISSOLVED METALS

Lab Sample No.:	59107	59104	59171	59101	59097	59094	59092	59088	59714
Field Sample No.:	80068	80065	80062	80059	80055	80052	80043	80038	80071
Date:	8/16/91	8/14/91	8/17/91	8/16/91	8/14/91	8/15/91	8/14/91	8/15/91	8/17/91
Location:	MW1B	MW2B	MW3B	MW4B	MW5B	MW6B	MW11B	MW12B	MW13B
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	13.5 B	21.9 B	15.4 B	16.0 B	10.0 U	12.5 B	12.6 B	614	55.1 B
Arsenic	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Barium	136 B	66.1 B	7.1 B	86.8 B	86.3 B	30.1 B	51.8 B	102 B	41.7 B
Beryllium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	11900	16600	5510	11200	12600	10400	10800	59700	30500
Chromium	3.4 B	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	21.0	2.5 B
Cobalt	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.8 B	2.0 U	2.0 U
Copper	1.0 U	1.0 U	1.0 U	2.0 U	1.0 U	1.0 U	1.8 B	9.1 B	3.7 B
Iron	30.4 B	52.7 B	14.8 B	49.3 B	24.8 B	20.3 B	510	55.6 B	56.2 B
Lead	1.0 U	1.0 U	1.4 B	1.0 U	1.0 U	2.0 B	1.0 U	3.1 B	1.0 B
Magnesium	5930	7990	1600 B	4330	5410	3710 B	5850	67.2 B	7490
Manganese	11.0 B	15.7	20.0	25.9	18.7	18.7	39.0	1.3 B	807
Mercury	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Potassium	3180 B	2670 B	400 U	4380 B	3830 B	1760 B	9270	148000	13600
Selenium	1.0 U	3.8 B	1.5 B	2.4 B	1.0 U	1.0 U	3.4 B	1.3 B	1.0 U
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Sodium	7680	11900	29300	7110	8070	8700	18300	61500	74000
Thallium	1.5 B	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vanadium	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	3.0 U	2.5 B	2.0 U
Zinc	14.2 B	15.5 B	15.2 B	18.1 B	18.2 B	28.7	32.5	28.8	19.6 B

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-4 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
DISSOLVED METALS

Lab Sample No.:	59108	59105	59172	59102	59098	59095	58619	58617	59089	59109
Field Sample No.:	80069	80066	80063	80060	80056	80053	80049	80045	80040	80109
Date:	8/16/91	8/16/91	8/17/91	8/16/91	8/14/91	8/15/91	8/13/91	8/13/91	8/16/91	8/16/91
Location:	MW1C	MW2C	MW3C	MW4C	MW5C	MW6C	MW7C	MW10C	MW11C	MW12C
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Parameter:										
Aluminum	19.9 B	32.7 B	32.3 B	21.1 B	17.9 B	26.7 B	14.3 B	15.8 B	15.6 B	31.1 B
Arsenic	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.4 B	1.0 U	1.0 U	1.0 U	1.0 U
Barium	25.4 B	18.4 B	21.4 B	26.7 B	23.7 B	33.1 B	50.8 B	20.0 B	26.2 B	57.6 B
Beryllium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	19100	8730	10600	12100	11900	11200 *	26000	18300	25800	24000
Chromium	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.3 B	2.0 U	2.2 B
Cobalt	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Copper	1.0 U	2.9 B	8.6 B	1.0 U	3.1 B	1.0 U	7.7 B	11.1 B	1.0 U	1.3 B
Iron	29.7 B	89.9 B	53.0 B	342	44.0 B	97.7 B	27.1 B	51.5 B	1130	127
Lead	1.0 U	1.2 B	2.0 B	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.4 B	6.3
Magnesium	3690 B	2040 B	2500 B	4120 B	4320 B	2250 B	4070 B	3280 B	4970 B	5620
Manganese	52.9	81.1	18.0	243	18.3	8.7 B	106	180	117	182
Mercury	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Potassium	821 B	1930 B	606 B	1880 B	2730 B	29400	17300	17000	849 B	22400
Selenium	1.0 U	1.0 U	1.0 U	3.8 B	1.0 U	1.0 U	2.2 B	1.7 B	1.4 B	1.0 U
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Sodium	4760 B	8890	26900	6140	8830	21100	13400	14500	7910	22800
Thallium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.2 B	1.0 U	1.0 U	1.0 U
Vanadium	2.3 B	2.0 U	2.0 U	2.0 U	2.0 U	3.0 B	2.0 U	2.0 U	2.0 U	2.0 B
Zinc	7.7 B	33.2	161	9.7 B	18.2 B	25.8	10.1 B	11.9 B	18.1 B	13.2 B

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

TABLE 5-4 (cont.)
ANALYTICAL DATA FOR GROUND-WATER SAMPLES
DISSOLVED METALS

Lab Sample No.:	59099	59091	59111	59112	59110	59176
Field Sample No.:	80057	80043	80115	80118	80115	80127
Date:	8/14/91	8/16/91	8/15/91	8/15/91	8/15/91	8/19/91
Location:	MW5D	MW11D	Dup. of MW6B	MW11E*	Bailer Rinse	Field Blank
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l

Parameter:

Aluminum	31.0 B	10.0 U	30.2 B	23.9 B	10.8 B	25.5 B
Arsenic	1.0 U	1.0 U	1.1 B	1.0 U	1.0 U	1.0 U
Barium	7.0 B	1.1 B	35.1 B	4.8 B	2.8 B	1.0 U
Beryllium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	55000	31300	10400	32100	52.9 B	4650 B
Chromium	2.0 U	2.0 U	4.8 B	3.5 B	4.2 B	2.0 U
Cobalt	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Copper	1.0 U	1.0 U	1.3 B	1.0 U	1.0 U	1.0 U
Iron	45.6 B	26.4 B	41.2 B	31.5 B	5.0 U	5.0 U
Lead	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Magnesium	7970	4880 B	3820 B	5140	88.4 B	50.0 U
Manganese	352	72.3	19.8	75.2	1.0 U	2.3 B
Mercury	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Potassium	2240 B	2100 B	2670 B	2800 B	636 B	400 U
Selenium	1.0 U	4.4 B	1.0 U	1.0 U	1.0 U	1.0 U
Silver	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Sodium	5650	14600	8710	15000	263 B	50.0 U
Thallium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vanadium	2.0 U	2.0 U	3.8 B	4.0 B	3.5 B	2.0 U
Zinc	14.8 B	3.4 B	35.8	4.5 B	4.3 B	10.7 B

Notes:

J- Compound was present but result was less than detection limit

B- Analyte was found in the laboratory blank

U- Compound was not detected

* - MW11E was a duplicate of MW11D which was taken from City Well #9

TABLE 5-5
ANALYTICAL DATA FOR MONITORING WELL SOIL SAMPLES
VOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	57127A	57126	57128A	55529B	57798A	57799A
Sample No.:	64022	64020	64024	62498	64028	64031
Date:	8/1/91	8/1/91	8/1/91	7/12/91	8/7/91	8/7/91
Location:	MW6C	MW6C	MW6C	MW7C	MW13B	MW13B
Depth:	30-32 ft.	45-47 ft	50-52 ft		35-37 ft	45-47 ft
Units:	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Dilution:	1.0	2.0	5.0	1.0	1.0	1.0

Parameter:

Acetone	12 U	4100 U	62 U	11 J	16 X	12 U
Methylene chloride	10	2000 U	46	95 B	6 U	6 U
Carbon disulfide	11	5500	57	6 U	38	6 U
Tetrachloroethene	6 U	32000	31	6 U	6 U	6 U

Notes:

U - Compound was not detected

X - Mass spectrum does not meet EPA CLP criteria but compound presence is strongly suspected

B - Analyte was found in the laboratory blank

J - Compound was present but result was less than the detection limit

TABLE 5-6
ANALYTICAL DATA FOR MONITORING WELL SOIL SAMPLES
SEMIVOLATILE ORGANIC COMPOUNDS

Lab Sample No.:	57800	57801	57130	57129	57131	55529
Sample No.:	64029	64032	64023	64021	64025	62498
Date:	8/7/91	8/7/91	8/1/91	8/1/91	8/1/91	7/12/91
Location:	MW13B	MW13B	MW6C	MW6C	MW6C	MW7C
Depth:	35-37 ft	45-47 ft	30-32 ft	45-47 ft	50-52 ft	
Units:	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Dilution:	0.50	0.50	1.00	1.00	1.00	1.00
Parameter:						
2-Methylnaphthalene	390 U	380 U	780 U	22000 E	810 U	390 U
Acenaphthylene	390 U	380 U	780 U	9300	810 U	390 U
Acenaphthene	390 U	380 U	780 U	2400	810 U	390 U
Dibenzofuran	390 U	380 U	780 U	1300	810 U	390 U
Flourene	390 U	380 U	780 U	12000	810 U	390 U
Anthracene	390 U	380 U	780 U	7500	810 U	390 U
Fluoranthene	390 U	380 U	780 U	14000	810 U	390 U
Pyrene	390 U	380 U	780 U	15000 E	810 U	390 U
Phenanthrene	390 U	380 U	780 U	22000 E	810 U	390 U
Benzo(a)anthracene	390 U	380 U	780 U	8400	810 U	390 U
Chrysene	390 U	380 U	780 U	7200	810 U	390 U
Indeno(1,2,3-cd)pyrene	390 U	380 U	780 U	2700	810 U	390 U
bis(2-Ethylhexyl)phthalate	390 U	380 U	780 U	640 JX	810 U	650
Benzo(b)fluoranthene	390 U	380 U	780 U	5700 Z	810 U	390 U
Benzo(a)pyrene	390 U	380 U	780 U	6300	810 U	390 U
Dibenz(a,h)anthracene	390 U	380 U	780 U	640 J	810 U	390 U
Benzo(g,h,i)perylene	390 U	380 U	780 U	2500	810 U	390 U

Notes:

- E - Sample was diluted with a factor of 4.0
- J - The compound is present but is less than detection limit
- X - Mass spectrum does not meet EPA CLP criteria, but presence of compound is strongly suspected
- Z - This is the average of Benzo(B)fluoranthene and Benzo(B)fluoranthene
- U - No detections in that sample

TABLE 5-7
ANALYTICAL DATA FOR MONITORING WELL SOIL SAMPLES
TOTAL METALS

Lab Sample No.:	57130	57129	57131	57802	57801
Sample No.:	64023	64021	64025	64030	64032
Date:	8/1/91	8/1/91	8/1/91	8/7/91	8/7/91
Location:	MW6C	MW6C	MW6C	MW13B	MW13B
Depth of Sample:	30-32 ft	45-47 ft	50-52 ft	35-37 ft	45-47 ft
Units:	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg

Parameter:

Aluminum	757	1330	3110	1270	334
Arsenic	9.6	0.94 B	11.1	12.0	0.61 B
Barium	3.7 B	6.0 B	10.4 B	3.0 B	61.9 B
Calcium	80.7 B	117 B	568 B	232 B	1.1
Cobalt	1.1 U	1.4 U	8.0 B	2.3 B	0.97 U
Chromium	16.6	7.6	31.8	8.9	5.8
Copper	2.4 B	1.4 U	5.3 B	2.9 B	1.4 B
Iron	6270	6610	12800	5490	2230
Lead	3.3	3.0	7.4	2.4	1.0
Manganese	76.5 B	119 B	296 B	288 B	49.4 B
Manganese	0.44 U	14.8	24.5	12.4	9.3
Nickel	2.7 B	2.3 U	15.7	6.8 B	1.6 U
Potassium	248 B	144 B	664 B	367 B	116 B
Selenium	0.82 B	0.85 U	0.91 B	1.5	0.77 U
Silver	0.54 B	0.57 U	0.47 U	0.38 U	0.39 U
Sodium	24.3 B	35.5 B	47.8 B	39.4 B	43.7 B
Thallium	0.22 U	0.28 U	0.24 U	0.75 B	0.19 U
Vanadium	7.1 B	9.3 B	25.5	10.6	1.6 B
Zinc	4.9	5.2 B	49.5	15.7	3.4 B

Notes:

B - Compound found in the laboratory blank as well as in the sample
U - Not detected

No semivolatile organic compounds were detected in the samples from Well 13B, or from Well 6C (30-32 feet and 50-52 feet). Only bis(2-ethylhexyl)phthalate was detected in the sample from Well 7C. Several PAHs were detected in the soil sample collected at 45 to 47 feet in Well 6C (see Recommendation 2).

6.0 DISCUSSION

Although the primary purpose of this report is to present the data derived during ground-water investigation activities, some preliminary conclusions may be made based on these data and on knowledge of potential background sources in the area surrounding the site. The findings of this investigation generally are in agreement with previous investigations (Versar, 1985). The following points are offered for further consideration in the final RI report:

- Ground-water flow in the Columbia aquifer is generally toward the east or east-southeast, toward the St. Jones River. This information is consistent with results of previous studies.
- From the results of this study, ground-water flow in the Frederica aquifer appears to be generally toward the east-northeast toward the St. Jones River. This flow direction contradicts previous reports (Versar, 1985) and is not consistent with the general slope of the geologic formations in the Dover area. Although the water level measurements are consistent between August 11, 1991 and November 1, 1991, flow direction is inferred by a very limited number of points and, therefore, the ground-water flow direction could be misrepresented by the data. However, it is important to note that no significant impact from site-related compounds was found in the Frederica aquifer.
- Downward vertical gradients, as determined from relative head measurements, exist between the Columbia and the Frederica, and the Frederica and Cheswold aquifers. However, it is unlikely that any substantial interconnection exists between these aquifers because of the thickness and low permeability of the confining zones between the aquifers. The 1985 pump test conducted by Versar (Versar, 1985), and approved by DNREC, showed that virtually no interconnection existed between the Columbia and the Cheswold aquifers.
- Volatile organic compounds, which include BTEX, were present with greater frequency, and often in greater concentration, in the relatively shallow "A" series wells than in the relatively deeper "B" series wells, which are screened in the Columbia aquifer. Concentrations were higher on-site and at Well Cluster 6

than at other locations. Well Cluster 6 is southeast of the site, between the site and City of Dover Well No. 9.

- Semivolatile compounds were found in ground-water samples only from the relatively shallow "A" series wells (2A, 4A, 5A, and 15A/B) which are on-site or close to the site boundary.
- PAHs were detected in greater concentration in Well 6A1/2 than in 6A, indicating that these denser compounds may tend to sink when present in high concentration, close to or above the limits of solubility. In addition, a greater concentration of volatile organic compounds was found in 6A1/2 than in 6A. Indications of a possible dense liquid phase in Well 6A1/2 were found during the 1985 investigation. The presence of a dense phase also was indicated during the current investigation.
- In the earlier investigation, naphthalene was found in Well 6B (former Well 6C) at a concentration of 4.6 µg/l, erroneously suggesting that traces of this compound had transgressed the confining layer and reached the Frederica aquifer. The results of this current study, however, indicate that this well was misplaced vertically and that no site-related compounds exist in the replacement Well 6C. The Frederica appears to be unaffected by site-related compounds, with the exception of a questionable presence of benzene below method detection limits in Well 12C.
- Earlier investigations concluded that site-related PAH compounds may have migrated off-site southeast toward Well Cluster 6 in the Columbia aquifer. The levels of PAHs in Wells 4A, 6A, and 6B, combined with the inferred ground-water flow direction in the unconfined Columbia aquifer, suggest that organic compounds from the Dover Gas Light Site, or from other local sources, have migrated within the unconfined Columbia aquifer in the direction of ground-water flow (east by southeast). These compounds appear to be confined within a very limited area of approximately one city block or less.

It is unlikely that all of the organic compounds in the aquifer originated on, or migrated from, the site for the following reasons:

- Total BNAs and total BTEX were detected in Well 6B at high levels, while no BNAs were detected in the on-site "B" wells, and the total amount of BNAs and BTEX at Well 6B were higher than in the on-site Well 15A/B. A dry cleaning

establishment with underground fuel storage tanks is known to have existed immediately upgradient from Well Cluster 6 and downgradient from the site.

- Chlorinated VOCs have been shown to be non-site related compounds because none of these compounds were used in the former gas manufacturing process on-site (Versar, 1991b). These compounds have been detected in various locations in the study area, most significantly in Well 6A1/2 where high levels of tetrachloroethane were detected. Several possible background sources exist for these chlorinated compounds, particularly the existing Capitol Cleaners dry cleaning establishment upgradient of the site, and the former Capitol Cleaners site upgradient of Well Cluster 6. A former State of Delaware laboratory existed near Well Cluster 13, possibly providing a source of the low levels of tetrachloroethane in Well 13B.
- Although total BTEX in Well 13B is at a level such that the site could be an upgradient source, there are several indications that this is not the only possible source of contamination. First, the concentration of benzene, the most mobile of the organic constituents found at the site, is higher in Well 13B than in the on-site Well 15A/B, indicating that the source of benzene in Well 13B is closer than the site. Second, no benzene was found in Wells 13A, 12A, or 12B, which lie between the site and Well 13B. Third, styrene, a moderately mobile volatile organic compound that has been identified as a site-related compound, was not found at this location and only BTEX has been found there. Fourth, the location of Well 13B has heating oil or gasoline underground storage tanks located on three sides, either upgradient or side-gradient. One set of tanks was replaced in recent years due to a suspected leak, according to the State of Delaware Division of Facilities Management.

From examination of the concentrations and locations, both horizontal and vertical, of detected VOCs and BNAs in the Columbia aquifer, it appears that organic compounds from the site may have migrated off-site, toward the southeast, based on the results of sampling at Well Cluster 4; however, it also appears that there may be three or more additional overlapping or adjacent plumes within the aquifer.

One additional plume is suggested by the high levels of non-site related chlorinated organic compounds in Well Cluster 6 where the dry cleaner existed immediately upgradient. In addition, this dry cleaning establishment also had at least two underground storage tanks that may have been a source of BTEX and PAHs in the aquifer. There also is the possibility that the chlorinated solvents in the aquifer are producing a "solvent effect" and are, therefore,

enhancing the mobility of PAHs within the aquifer. A second additional plume may be originating near the dry cleaning establishment located to the northwest of the site, producing the levels of tetrachloroethane found in Wells 15A/B and 3A. Well 3A is located "side-gradient" and very slightly downgradient of Well 15A/B. It is significant to note that a higher level of tetrachloroethane was found in Well 3A than in Well 15A/B, indicating that the site is not the source of this compound. Finally, a third additional plume, likely resulting from leaking underground storage tanks or from the former State of Delaware laboratory operations, may exist immediately adjacent to Well Cluster 13, which is furthest east from the site. This is evident from the higher concentrations of benzene at this location and the lack of detection of organic compounds in Wells 12A and 12B, which are located between the site and Well Cluster 13.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the data derived from the 12 off-site wells that were drilled during this study, the on-site well drilled during April 1991, and ground-water sampling data derived from sampling these wells and the existing on-site and off-site wells. The purpose of the well drilling and sampling program was to provide information regarding the nature and extent of contamination in the aquifers underlying the site, as well as aquifer characteristics such as ground-water elevations. Further evidence regarding the extent and chemical and physical nature of the potential plumes is presented here to identify potential Phase II ground-water investigation activities.

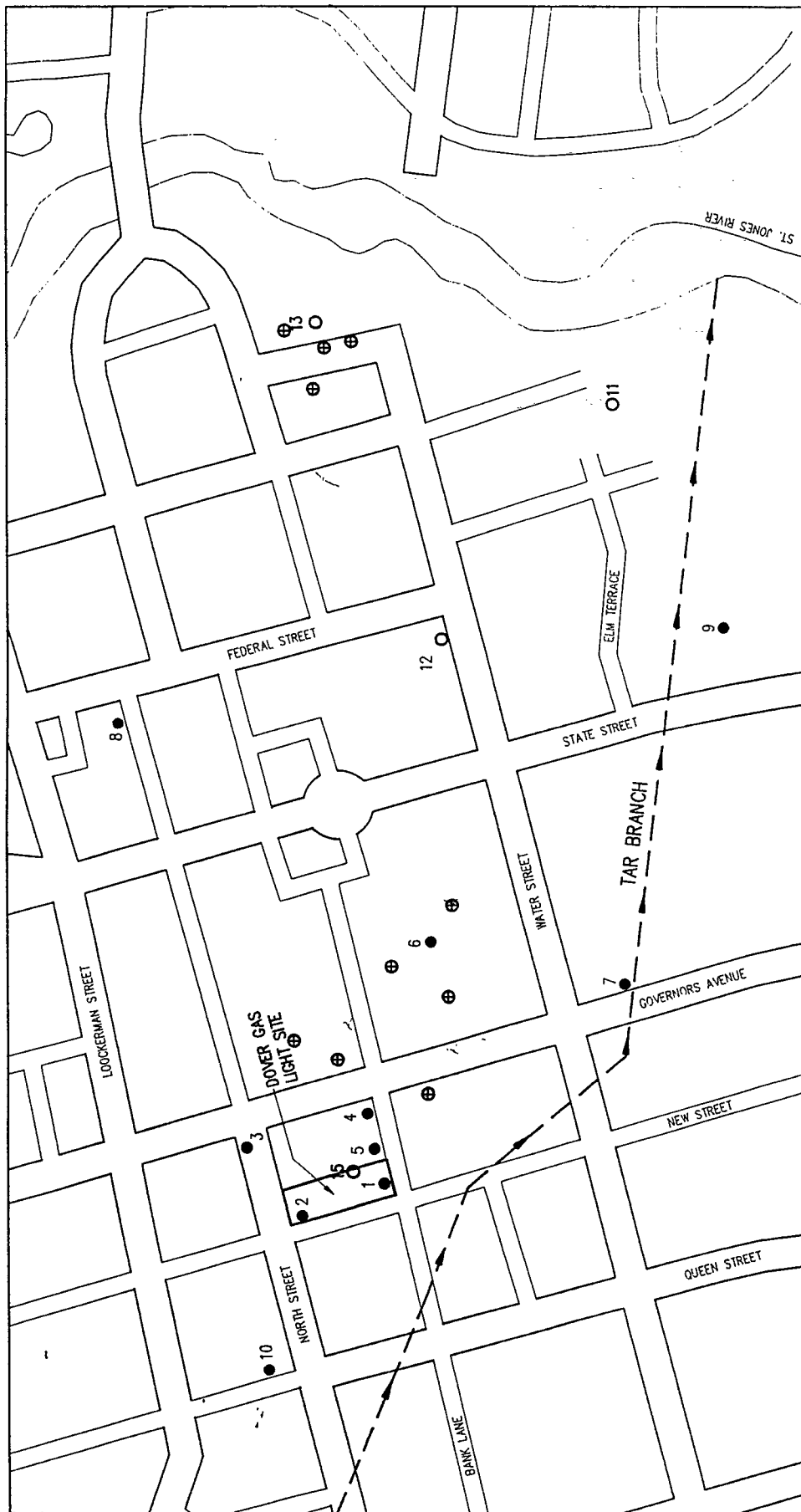
As shown in the figures and text of this report, the possible plume from the site is confined to a limited portion of the study area and only in the Columbia aquifer. No site-related compounds were detected at any depth in Wells/Clusters 1, 3, 7, 8, 9, 10, 11, or 12 (with the exception of a questionable presence of benzene below detection limits in Well 12C). None of the "C" or "D" wells are impacted by site-related organic compounds, except as previously noted. The Frederica and Cheswold aquifers are, therefore, apparently unaffected by the site. The width of any plume is probably relatively narrow, as indicated by no detection of BTEX in Wells 1A, 3A, 7A, and 8A. The length of any possible plume also is limited, and probably does not extend much beyond Well Cluster 6, which is approximately 600 feet southeast from the site. Because of the overlap of at least two other possible plumes at Well Cluster 6, the extent of any site-related impact at this location is difficult to distinguish. The results of this study confirm the previous hypothesis and conclusion (Versar, 1985) that the mobility of site-related compounds in the ground water is very limited. The ground-water quality data indicate that the probable direction of migration of compounds is from Well 4A toward Well Cluster 6, which follows the general direction of ground-water flow, in an east-southeasterly direction.

As a result of the above conclusions, it is recommended that further investigatory work be performed toward two objectives:

1. Further research and possible field work to better determine the impact of background sources on the areas around Well Clusters 6 and 13, and to better determine the source of contamination in Well 13B. This task may be accomplished partly by extending the scope of the background sources inventory to further investigate these two areas. In addition, if intensive research does not supply enough information, exploratory soil borings may be useful in locating the source of the hydrocarbons at Well Cluster 13. Field screening methods and laboratory analysis of BTEX and TRPH could be utilized for selected soil samples. Soil borings would be advanced into the Columbia aquifer, to a depth dependent on qualitative field observations. The use of soil borings is suggested rather than wells because the compounds of interest in this investigation have been shown to be only slightly mobile in ground water (see Figure 7-1).
2. Possible further field work to better identify the possible width of the plume, and its extent beyond Well Cluster 6, in the Columbia aquifer only. This task also may be accomplished by the use of exploratory soil borings located immediately to the northeast and southeast of the line between Well Clusters 4 and 6, and immediately downgradient of Well Cluster 6. One or two soil borings in each location could be combined with field screening and laboratory analysis of selected soil samples for BTEX and TRPH. Soil boring depths should extend to at least the same depth as Well 6A1/2 because of the possibility of a dense phase existing at that depth, and possibly to the bottom of the Columbia aquifer, without penetrating the confining silt zone (approximately 50 feet BGS) (see Figure 7-1). This program also will provide further information regarding the PAH concentrations found in the Well 6C soil sample.

It is evident that any plume that may exist off site is limited to a small area of less than a city block in size. Lateral spread of possible site-related compounds is likely to be very limited, and is certainly limited to an area of less width than the plume length. This is based on the assumption that lateral dispersion of sorbing solutes is limited by dispersity: the greater the Koc, the less dispersive the compound. Even non-sorbing compounds would not disperse to an area wider than the length of the plume. As a result, installation of additional monitoring wells would not provide any new and meaningful information regarding plume characteristics.

FIGURE 7-1
PROPOSED POTENTIAL PHASE II OFF-SITE SOIL BORINGS
DOVER, DELAWARE



161\6527\107\PG7-1.DWG DATE: 11-05-91

REFERENCES

- Berenson, N.B. 1989. Letter from N.B. Berenson, Morgan, Lewis, and Bockius, to Paul Racette, U.S. EPA Region III. September 14, 1989.
- DNREC. 1985. Hydrogeologic Investigation of the Dover Gas Light Site, Dover, Delaware. Delaware Department of Natural Resources and Environmental Control, Solid Waste Branch. January 1985.
- Dover. 1975. Dover Comprehensive Development Plan. City of Dover Planning Commission.
- Duffield Associates, Inc. 1984. Subsurface Evaluation, Kent County Family Court Building, W.O. S17. July 1984.
- Engineering-Science, Inc. 1991a. Geophysical Survey, Dover Gas Light Site, Dover Delaware. Fairfax, Virginia. March 1991. p6.
- Engineering-Science, Inc. 1991b. Phase 1A Archaeological Assessment of the Dover Gas Light Company Site, Dover, Delaware. Washington, D.C. May 1991. p38.
- Hawley, G.G. 1981. The Condensed Chemical Dictionary, 10th edition, Van Nostrand Reinhold Company. 1981. p1135.
- Johnston, R.H. 1973. Hydrogeology of the Columbia (Pleistocene) Deposits.
- Johnston, R.H. and P.P. Leahy. 1977. Combined Use of Digital Aquifer Models and Field Base-Flow Data to Identify Recharge-Leakage Areas of Artesian Aquifers. Journal Research U.S. Geological Survey, 5(4):491-496.
- Leahy, P.P. 1982. Ground-water Resources of the Piney Point and Cheswold Aquifers in Central Delaware as Determined by a Flow Model. Delaware Geological Survey Bulletin No. 16. 68p.
- Pickett, T.E. and R.N. Benson, 1983. Geology of the Dover Area. Delaware Geological Survey. Geologic Map Series, No. 6.
- Sullivan, J. 1991. Memorandum to Steve Johnson and Steve Williams, DNREC. July 16, 1991.

Versar, Inc. 1985. Environmental Assessment for the Dover Gas Light Site.
Springfield, Virginia. December 1985.

Versar, Inc. 1991a. Final Aerial Photographic/Historical Map Investigation Report for
the Dover Gas Light Site. Springfield, Virginia. April 1991. p28.

Versar, Inc. 1991b. On-site Source Characterization Report for the Dover Gas Light
Site, Dover, Delaware. Springfield, Virginia. April 1991.

Versar, Inc. 1991c. Off-site Pathway Analysis for the Dover Gas Light Site, Dover,
Delaware. Springfield, Virginia. October 1991.

Versar, Inc. 1991d. Remedial Investigation/Feasibility Study Work Plan, Springfield,
Virginia. May 1991.

Woodruff, K.D. 1972. Geohydrology of the Dover Area, Delaware. Delaware
Geological Survey, Hydrologic Map Series No. 1.

APPENDIX A

OFF-SITE SOIL BORINGS
FIELD OBSERVATION REPORT

AR301285

DOVER GAS LIGHT

A truck-mounted drill rig with a 6 5/8-inch hollow-stem auger was utilized to drill a borehole to 5 feet below the surface, and then continuous split spoons were installed until reaching the ground-water table. The hollow-stem auger was drilled down to the bottom of the former spoon location after each spoon sample collection, to prevent the collapse of the borehole. The split-spoon sample collection was initiated from 5 feet below the surface because of the water table elevation variations. The drilling crew had enough hollow-stem auger sections to perform the installation of four 15 foot borings without having to steam clean. They also had five split spoons, which allowed for the continuous collection of split spoon samples without having to constantly decontaminate the spoons. After all the hollow-stem augers and drill bits had been utilized, they were steam cleaned. The split spoons were washed with a non-phosphate detergent, rinsed with water, rinsed with hexane and then rinsed with deionized water, after which they were allowed to air dry prior to the next use.

Soil samples were collected from either the soil water interface or just above this interval. The determination as to whether a sample was collected at the interface or just above was based on readings from a screening with an HNu, detectable odors, and a visual inspection of the spoon samples for obvious staining. Samples were collected and placed into the appropriate sampling container, which is based on the type of analysis to be performed. Samples were collected for volatile organic compound (VOC) analysis, and base neutral acid (BNA) extraction analysis. The BNA samples were covered with an aluminum foil layer prior to placing the lid on the jar in order to perform a head space analysis prior to sample shipment to the lab. A sample of soil also was collected for analysis in the field with the Hanby test kit. All samples were collected by hand. Versar personnel wore PVC gloves covered with a nitrile glove for the purpose of sampling. The gloves were changed prior to each sample collection to prevent cross contamination. Sample containers were precleaned by the manufacturer and were tested prior to shipment as part of their quality assurance and quality control (QA/QC). Once the samples were collected, they were kept on ice in a cooler until they reached Versar's laboratory in Springfield, Virginia.

The following chart indicates the results of the Hanby field test and the head space analysis.

<u>Boring</u>	<u>Hanby</u>	<u>Headspace</u>
OB-1	200 ppm	50 ppm
OB-2	0-1 ppm	6 ppm
OB-3	50 to 75 ppm	50 ppm
OB-4	0-1 ppm	3 ppm
OB-5	0-1 ppm	10 ppm
OB-6	0-1 ppm	3 ppm
OB-7	0-1 ppm	6 ppm
OB-8	0-1 ppm	7 ppm
OB-9	0-1 ppm	4 ppm
OB-10	0-1 ppm	6 ppm
OB-11	0-1 ppm	3 ppm
OB-12	0-1 ppm	10 ppm
OB-13	0-1 ppm	12 ppm
OB-14	0-1 ppm	1 ppm

OB-1

The offsite boring (OB) #1 was located approximately 3 feet from the curb on the south side of Bank Lane, just west of the intersection of Bank Lane and Governors Avenue. The asphalt road had to be cut through prior to drilling. A total of four split-spoon samples were collected. The water table was encountered at approximately 12 feet. A strong coal tar-like odor was emanating from the borehole and grew stronger with depth. The soils from this boring were observed to be stained. The highest HNu reading from this borehole was 20 ppm. Samples for the Hanby field test kit and headspace analysis were only collected from the 11- to 13-foot interval. This boring is assumed to have high concentrations due to its close proximity to the Dover Gas Light Site and, therefore, was not analyzed for the parameters indicated above. Any leftover cuttings were placed in 5-gallon containers until they could be placed in a 55-gallon drum at the Chesapeake Utilities yard.

OB-2

OB-2 is located on the east side of Governors Avenue, approximately 250 feet from the intersection of Bank Lane and Governors Avenue. This boring was installed in a grassy area between the sidewalk and the curb along the road. A total of 5 split-spoon samples were collected and the water table was encountered at approximately 11 feet. A humic odor could be detected from the soils. The highest HNu reading was 10 ppm. Samples were collected from the 9- to 11-foot interval and were split with Tony Vellious, EPA representative.

OB-3

OB-3 was located on Bank Lane, approximately 50 feet east of Governors Avenue. The road had to be barricaded prior to the installation of this boring, which caused some delays in initiating the drilling. The asphalt also had to be cut before the startup of drilling. A total of 5 split-spoons were collected and the water table was encountered at approximately 14 feet. A distinctive coal tar-like odor was noted to emanate from the borehole and some of the soils appeared to be stained. HNu readings ranged from 1 ppm to 15 ppm. Samples were collected from the 13- to 15-foot interval and were placed in a cooler. Extra cuttings were placed in 5-gallon containers until they could be placed in a 55-gallon drum at the Chesapeake Utilities yard.

OB-4

OB-4 was located on the eastern end of Bank Lane near The Green. The asphalt had to be cut prior to drilling. Steve Johnson with DNREC was on-site for the drilling of this boring. A total of 6 split-spoon samples were collected in order to penetrate the soil water interface. The water table was located at approximately 16 feet. Soil samples were collected at the 13- to 15-foot interval and placed in a cooler. The highest HNu reading was 3 ppm. There was no particular odor to the soils from this boring and the soils appeared to be clean.

OB-5

OB-5 was located just east of State Street on The Green. The boring was located in a grassy area and a total of 9 split-spoon samples were collected in order to breach the soil water interface. The water table was at approximately 22 feet below the surface. This area appeared to be more elevated than the surrounding area. The samples were collected from

the 19- to 21-foot interval. There was no particular odor to the soils and the soils appeared to be clean.

OB-6

OB-6 was located in the northeast corner of the Water Street parking lot. The area where the boring was installed was grassy, and the boring location had to be moved several feet to the east to avoid underground electrical wires. A total of 5 split-spoon samples were collected and the water table was encountered at approximately 14 feet. The samples were collected at the 13- to 15-foot interval and were split with Tony Vellious. At Mr. Vellious' request, blank samples also were collected at this time. The soils in this boring appeared to be clean and there was no particular odor. HNu readings ranged from 1 ppm to 3 ppm.

OB-7

OB-7 was located approximately 400 feet south of the intersection of State Street and Water Street. This boring was relocated a little further to the east to avoid overhead utilities. A total of 5 split-spoon samples were collected, and the water table was encountered at approximately 14 feet. The last two spoon samples collected had some thin, dark stained layers which had a distinctive coal tar-like odor. The upper samples had no particular odor. Samples were collected from the 13- to 15-foot interval, where most of the dark stained layers were located. The samples were placed in a cooler. The HNu readings ranged from 0 ppm to 1 ppm.

OB-8

OB-8 was located on a grassy area between the county buildings located on Federal Street. This boring location was moved slightly to the north to avoid any underground utilities. A total of 6 split-spoon samples were collected, but the water table was never penetrated because the hammer mechanism lost a piece and would not operate. The 15-to 17-foot interval was sampled and is believed to be just above the water table. There was no particular odor to the soils and the soils appeared to be clean. The HNu readings were all 0 ppm.

OB-9

OB-9 was located in a grassy area east of a parking area which is just southwest of the intersection of York Avenue and Federal Street. This boring was installed after 2 hours of

downtime caused by rain. It rained during the collection of the last few split-spoon samples. A total of 6 split-spoon samples were collected in order to penetrate the water table. Samples were collected from the 15- to 17-foot interval and the ground-water table was at approximately 16 feet. The highest HNu reading was 1 ppm. There was no odor and the soils appeared to be clean.

OB-10

OB-10 was located in a grassy area on the south side of William Penn Street, between a state building and the armory. This boring was moved approximately 2 feet to the north which assisted the drillers in the placement of the drill rig. A total of 7 split-spoon samples were collected in order to reach the water table. Samples were collected from the 17- to 19-foot interval and the water table appeared to be at 18 feet. The highest HNu reading was 1 ppm. There was no particular odor associated with the soils from this boring.

OB-11

OB-11 was located approximately 75 feet south of the intersection of William Penn Street and Legislative Avenue on the east side of the road. During the drilling of this bore hole, an 18-inch layer of concrete was encountered. The drillers broke through the concrete with a jackhammer, which was a time-consuming task. A total of 5 split-spoon samples were collected and the water table was encountered at 14 feet. Samples were collected from the 13- to 15-foot interval. The soils associated with the boring did not have any particular odor. The highest HNu reading was 6 ppm from the 5- to 7-foot interval.

OB-12

OB-12 was located at the southeast corner of the parking lot associated with the armory located off East Water Street and Legislative Avenue. The drillers had to cut through the asphalt pavement prior to drilling. A total of 6 split-spoon samples were necessary to breach the water table. Samples were collected from the 15- to 17-foot interval. The soils associated with this soil boring did not have any particular odor other than slightly musty or humic. The highest HNu reading was 2.7 ppm.

OB-13

OB-13 was located on the church property off Kerbin Street. This boring was moved approximately 30 feet to the north to avoid a conflict with overhead utilities. A total of 7 split-

spoon samples were collected and the ground-water table was at approximately 18 feet from the surface. Samples were collected from the 17-to 19-foot interval. The upper soils had a slightly humic odor. The lower soils did have an odor similar to that encountered at the bore holes on Bank Lane. The highest HNu reading was 5 ppm.

OB-14

OB-14 was located at the adjacent designated parking locations for the state representatives on the north side of the building. The asphalt was cut and approximately 18 inches of concrete were broken up using a jack hammer. Once these obstacles were removed, drilling of the borehole was conducted. A total of 5 split-spoon samples were collected and the ground-water table was at approximately 13 feet. Samples were collected from the 13- to 15-foot interval. These soils did not have any particular odor and the highest HNu reading was 0.5 ppm.

APPENDIX B

OFF-SITE SOIL BORING LOGS,
NEW MONITORING WELL BORING LOGS,
AND NEW MONITORING WELL CONSTRUCTION DIAGRAMS

DRAFT

Versar INC.

GEOLOGIC LOG

JOB NUMBER: 6527.103.01

PROJECT: Dover Gas Light
 LOCATION: Banks Lane
 BOREHOLE NUMBER: OB-1
 DATE DRILLED: 6/13/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DELMA RIVA
 DRILLER: Jeff DeCarla
 DRILLING METHOD: Hollowstem auger / split spoon
 HOLE DIAMETER: 6 3/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: Asphalt

LOCATION	SKETCH
Governors Avenue Cemetery	

COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Drilled to 5 feet - cuttings: Dk./med. Brown fine to med sand. Strong coal tar odor
5 ft.	1	3' - 5'	4/4	4/4		1/2" Dk. gray/black silty sand, 2 3/4" med. brown fine to med grain sand, has black specks in it - (strong coal tar odor)
	2	5' - 10'	2/4	3/3		1' 10" med. brown fine to med. grain sand, Dk. specks in it - (strong coal tar odor)
9	3	10' - 14'	2/3	2/2		1" med. brown fine to med. grain sand, 2" dark brown fine med. grain sand, 2" med. brown fine to med. grain sand, 2" dark brown med. sand, 10" med. brown fine to med. sand, 1" Dk. brown fine to med. grain sand, 3 1/2" med. brown fine to med. sand, 2" med. brown fine to med. grain sand
	4	14' - 15'	1/1	1/1		2" med. brown fine to med. grain sand, 6" gray very fine to silty sand, 14" tan very fine silty sand.
						Did not collect 5th spoon
						Odor to strong & hit water table

11
Samples
Collected
Hemingway
10/13/91
65

N-Nu
10 ppm
5 ppm
7 ppm
20 ppm

GEOLOGIST'S SIGNATURE _____

PAGE _____ OF _____

AR301293

PROJECT: DOVER GAS LIGHT
LOCATION: Old Dry Cleaners - Governors Ave.
BOREHOLE NUMBER: OB-2
DATE DRILLED: 6/12/91
FIELD REPRESENTATIVE: Julian de la Fuente
DRILLING CONTRACTOR: DEL MARVA
DRILLER: Jeff DeCarlo
DRILLING METHOD: Hollow Stem / Split Spoon
HOLE DIAMETER: 6 5/8"
GROUND ELEVATION: _____
CONDITION OF GROUND SURFACE: Grassy

Governors Avenue

COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/ RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION
						(SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Drilled to Five Feet Cuttings: Humic Odor med. Brown to Dark Sand med. to fine grain ↓
1	5 to 7 ft	2 / 1 1/4"	2/3 3/4			2" Red Brown fine to med. grain sand, 4" grey clay w/ Red thin layers, 7" Red Brown fine to med. grain sand
2	7 to 9 ft	2 / 1 1/4"	1/3 1/2			1' 9" Red Brown fine to med. grain sand
3	9 to 11 ft	2 / 1 1/4"	2 1/2 1 1/2			1' 11" Tan / LT. Brown alternating layers fine to med. grains sand. Humic odor
4	11 to 13 ft	2 / 1 1/4"	0/0 1/1			1' 11" Tan fine to med. grain sand
5	13 to 15 ft	2 / 1 1/4"	3/1 17/24			8" Red Brown med. to coarse sand, small sub rounded pebbles, 5" light grey w/ reddish bands clay, 12" Red Brown med. sand

NNU

7 ppm

7 ppm

10

1.0 ppm

10 ppm

5 ppm

PAGE _____ OF _____

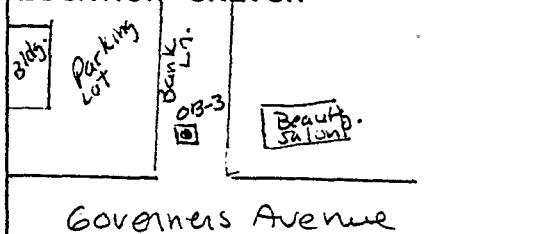
GEOLOGIST'S SIGNATURE

AR301294

PROJECT: DOVER COAS LIGHT
 LOCATION: Banks Lane, Adj. to Insurance Agency
 BOREHOLE NUMBER: OB-3
 DATE DRILLED: 6/13/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DEL MAR KA
 DRILLER: JEFF DECARIO
 DRILLING METHOD: Wallow Steen Auger/Split Spun
 HOLE DIAMETER: 6 5/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: Asphalt

JOB NUMBER: 6527.103.01

LOCATION SKETCH



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Drilled to 5 feet - cuttings: asphalt, 2" gravel till, med. Brown med. to coarse sand, dk. brown med. to coarse sand, lt. brown sand, clayey texture, pebbles
						Humic odor
	1	5 to 7 ft.	2/10"	3/4		1' 10" light/med. Brown fine to med. sand, some dark layers toward center - appears to be dark organic material
	2	7 to 9 ft.	2/10"	3/3		1' 10" Lt./med. Brown med. grain sand (alternating layers)
	3	9 to 11 ft.	2/10"	3/3		1' 8" Light/med. (alternating layers) fine to med. grain sand.
	4	11 to 13 ft.	2/10"	4/5		2" med. Brown fine to med. sand, 5" brick red silty clay, 4" tan var. coarse sand, 2" grey clay, 2" med. brown coarse sand, 5" grey clay w/ red banding
	5	13 to 15 ft.	2/10"	11/14		6" grey clay w/ red banding, stained brown/black coarse sand (odor - sulfur), 5" grey clay w/ red banding, dk. brown coarse sand
						no penetration odor Lower intervals had coal tar odor

1 ppm

3 ppm

3 ppm

5 ppm

15 ppm

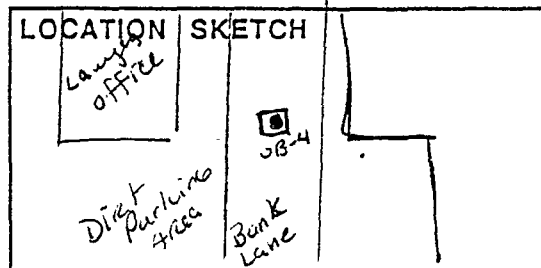
GEOLOGIST'S SIGNATURE

PAGE _____ OF _____

AR301295

JOB NUMBER: 6527.103.01

PROJECT: Dover Coas Light
 LOCATION: Bunk Lane, adjacent lawers office
 BOREHOLE NUMBER: JB-4
 DATE DRILLED: 6/13/91
 FIELD REPRESENTATIVE: Juana de la Fuente
 DRILLING CONTRACTOR: DEL MARCA
 DRILLER: JOE DECARLO
 DRILLING METHOD: Hollow stem Auger / Split Spun
 HOLE DIAMETER: 6 5/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: Asphalt



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Drilled to 5 feet - cuttings: asphalt. 2"
						med to dk brown silty sand, pebbles w/ small rocks, med to fine grain brick & shell fragments
5	1	5 to 7 ft	2/1 1/8"	2/3 3/6		1-4" dk brown / grey silty sand, 1-4" red brown med to fine grain sand w/ bands of dk. rust. & c.
7	2	7 to 9 ft	2/1 1/2"	4/6 7/8		1-4" dk brown / black fine to med grain silty like sand, 9" red / brown med to coarse sand, 1-4" red brown, dilute bands near bottom, coarse to very coarse sand.
9	3	9 to 11 ft	2/1 1/4"	4/6 6/7		2-4" light brown fine to med grain sand, 5" red brown coarse grain sand w/ pebbles to very coarse grain, 5" dk brown coarse grain sand, 3" tan fine grain sand 2" dk brown fine to med grain sand, 1" tan fine to med grain sand.
11	4	11 to 13 ft	2/1 1/8"	6/3 3/8		3" med brown fine to med grain sand, 5" red brown w/ dilute bands coarse grain sand, 7 1/2" grey clay w/ red bands, 1/2" tan coarse sand, 1 1/2" dk red brown fine to med grain sand, 1/2" dk red brown sand coarse grain.
13	5	13 to 15 ft	2/1 1/4"	3/2 2/4		3" dk brown w/ pebbles coarse to very coarse sand, 7" red brown fine to med grain sand, 10" grey clay to dk grey w/ red bands, 1" red brown coarse sand, 1" grey to dk grey clay w/ red bands.
15	6	15 to 17 ft	2/1 1/8"	4/5 4/2		2" grey clay, 1" tan coarse sand, 2" grey clay w/ red bands, 1" red brown coarse sand, 1 1/2" grey clay w/ thin red layers, 4" red brown fine to med grain sand, 6" grey clay w/ thin red layers, 1/2" red brown fine to med grain sand, 1/2" grey clay w/ thin red layers, 1" red brown / tan (alternating layers) very coarse sand, 3 1/2" red brown med to very coarse sand.

0 ppm

0 ppm

0 ppm

0 ppm

1 ppm

3 ppm

GEOLOGIST'S SIGNATURE _____

PAGE _____ OF _____

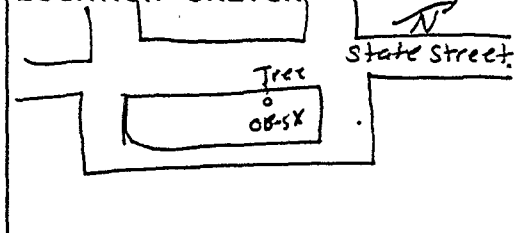
AR301296

GEOLOGIC LOG

PROJECT: Dover Gas Light
 LOCATION: The Green
 BOREHOLE NUMBER: OB-5
 DATE DRILLED: 6/19/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DELMAR Drilling
 DRILLER: Jeff DeCarlo
 DRILLING METHOD: Wallow Stem Auger / Split Spoon
 HOLE DIAMETER: 6 3/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: grass

JOB NUMBER: 6527.103.01

LOCATION SKETCH



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)	
						Augered 1st 5 feet. Silty Brown/Black top soil med to very fine silty sand. Some med. Brown - very fine silty sand to med sand. No particular odor.	4.00
5	1	2' 1 3/4"	5/3 3/4			1 3/4" med. Brown med to very coarse sand (small pebbles). Dark speckled @ 3" 7 1/2" 10 3/4" 14" no particular odor.	5 ppm
7	2	2' 1 3/4"	2/3 3/3			1 1/8" med. Brown med to very coarse sand (small pebbles). Dark spots @ 7 1/2" 10" 12" 18" 20" no particular odor.	5 ppm
11	3	2' 1 3/4"	2/2 3/2			1 1/8" med. Brown med to very coarse sand. DK spots @ 5" 11" 12" 14 1/2" - no particular odor.	5 ppm
13	4	2' 1 3/4"	2/3 5/5			6" med. Brown fine to medium grain sand, 5 1/2" Lt. Brown med to coarse sand, 5 1/2" med. Brown med to very coarse sand (small pebbles). 7" Lt. Brown med to coarse sand, 11" Lt. Brown med to coarse sand. 5 1/2" - appears that dk. material clings to rocks and can be scraped off.	0 ppm
15	5	2' 1 3/4"	2/3 3/3			2" med. Brown med to med. sand, 2" Lt. Brown coarse sand, 8" med. Brown coarse sand, 2" Lt. Brown med to coarse sand, 3" med. Brown coarse sand, 4" Lt. Brown coarse sand, 5" med. Brown coarse sand, Dark specks @ 2" 5" 8" 14" - no odor.	5 ppm
17	6	2' 1 3/4"	2/3 2/3			2" med. Brown med sand, 1" Lt. Brown coarse sand, 1" med. Brown coarse sand, 1" Lt. Brown coarse sand, 3" med. Brown coarse sand, 2" Lt. Brown coarse sand, 3" med. Brown med to coarse sand - DK. specks upper portion no particular odor.	5 ppm
19	7	2' 1 3/4"	2/3 4/3			9" Lt. Brown med to coarse sand, 3" Red Brown alt. Tan layers, 6" Lt. Brown sand med to coarse, 6" Red Brown alt. 4" tan layers fine to med. sand, Dark bands @ 18 1/2" no odor.	0 ppm
21	8	2' 1 3/4"	2/3 4/2			2 1/2" med. Brown very fine to med. sand, 2 1/2" Lt. Brown med sand, 5" alt. Lt. Brown/Red Brown layers med to coarse sand, 1 1/2" Red Brown med to coarse sand, 3 1/2" Lt. Brown med to coarse sand, 3 1/2" greenish silty 1/2" 1 1/2" pebbles.	0 ppm
23	9	2' 1 3/4"	2/3 10/10			3" med. Brown very fine to med. silty sand, 2" med. Brown fine to very coarse sand (6" pebbles), 2 1/2" Red silty clay, 3" med. Brown very coarse to fine sand, 2" med. Brown very fine to very coarse sand (pebbles), 1 3/4" Red Brown very fine to very coarse sand, 1 1/4" Gray Clay, 3 1/4" Red Brown med to very coarse sand.	5 ppm

GEOLOGIST'S SIGNATURE _____

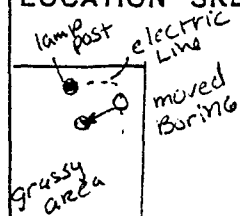
PAGE _____ OF _____

AR301297

JOB NUMBER: 6527.103.01

PROJECT: DOVER GAS LIGHT
 LOCATION: Water Street Parking Lot
 BOREHOLE NUMBER: OB-6
 DATE DRILLED: 6/12/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DELMARVA
 DRILLER: Jeff DeCarlo
 DRILLING METHOD: Hollow Stem/Split Spoon
 HOLE DIAMETER: 6 7/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: grassy

LOCATION SKETCH



Parking Lot

COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)	
						Drilled to 5 feet - cuttings: Humic odor	
						Red Brown Sand med to fine grain	HNU
						w/ small subrounded to subangular pebbles	
5	1	5 to 7 ft.	2 1/2	19/10		2" med. Brown, med. to fine sand, 2" Light Brown coarse sand, 12" Red Brown med. to coarse sand.	1 ppm
7						no particular odor	
	2	7 to 9 ft.	2 1/2	7/8		18" Red Brown fine to coarse sand, 10" Deep Brown red coarse sand.	3 ppm
9							
	3	9 to 11 ft.	2 1/2	2/3		22" Lt. Brown / Red Brown (alternating layers) fine to med. grain sand.	1 ppm
11							
	4	11 to 13 ft.	2 1/2	3/2		2" Lt. Brown / Red Brown (alternating layers) fine to med. grain sand, 1" grey clay w/ pebbles (med. to med. co.), 6" Red Brown fine to coarse sand, med. angular pebbles, 2" Lt. Brown fine to med. sand, 6" Red Brown med. to coarse sand w/ small pebbles, 2" grey clay, 5" Red Brown med. to coarse sand.	1 ppm
13							
53 mpu	5	13 to 15 ft.	2 1/2	9/12		8" Lt. Brown fine to med. sand, 5" grey w/ Red sand clay, 11" Red Brown fine to very coarse sand.	2 ppm
15							

GEOLOGIST'S SIGNATURE _____

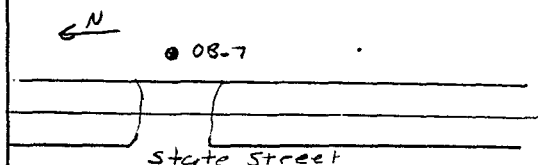
PAGE _____ OF _____

AR301298

JOB NUMBER: 6527.103.01

PROJECT: Dover Gas Right
 LOCATION: State Street - Church Property
 BOREHOLE NUMBER: GB-7
 DATE DRILLED: 6/14/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DELMARVA
 DRILLER: Jeff DeCarlo
 DRILLING METHOD: Hollow stem auger / split spoon
 HOLE DIAMETER: 6 5/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: grassy

LOCATION SKETCH



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Drilled to 5 feet: cutting s. med. to dk. brown. Fine to coarse green sand w/ med. to small pebbles. Humid odor
5	1	5 to 7 ft.	2/11.8"	5/9 8/6		6" Lt. Brown med. b. coarse sand, 9" Tan fine to med. grain sand w/ few sm. pebbles, 1" Tan fine sand w/ few sm. pebbles, 4" Tan med grain sand
7	2	7 to 9 ft.	3/11.9"	4/2 2/5		1" med. Brown med sand, 1.6" Lt. grey silty clay, 2" Lt. Red Brown med. to coarse sand
9	3	9 to 11 ft.	2/11.10"	4/5 7/9		2" grey silty clay, 3" Lt. Brown/red med. to coarse sand, 1" Gravel layer (sm. to med. pebbles), 1" med. Brown red med. to coarse grain sand, 2" med. Brown very fine to silty sand, 2 1/2" med. Brown fine sand, 1/2" dk. brown clay
11	4	11 to 13 ft.	2/11.10"	3/3 2/2		1" Lt. Red Brown coarse to very coarse sand w/ small pebbles, 1" Grey clay w/ red layers, 2" Red Brown med. to coarse sand, 1" Tan coarse sand, 1" Red Brown coarse sand, 2" Dk. organic material, 2" Dk. Red Brown coarse sand (has slight odor)
13	5	13 to 15 ft.	2/11.4"	2/3 5/6		1 1/2" Dk. Brown med. to coarse sand, 1 1/2" Dk. Brown w/ darker bands (slight odor) coarse sand, 3 1/2" med. Red Brown sand med. to very coarse sand w/ dark bands (slight odor), 1/2" Tan clay, 5" Red Brown w/ Dk. Black bands med. to very coarse sand (slight odor), 3" Red Brown coarse sand, 1" Tan fine to med. grain sand

No particu
odors

0 ppm

1 ppm

0 ppm

0 ppm

1 ppm

GEOLOGIST'S SIGNATURE _____

PAGE _____ OF _____

AR301299

COMMENTS:_____

0884

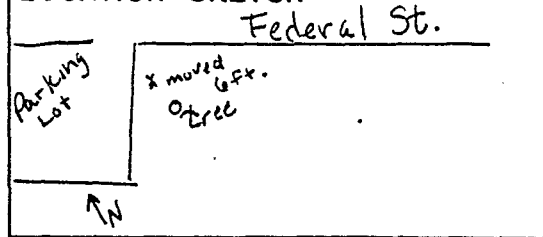
AR301300

GEOLOGIC LOG

PROJECT: Dover Gas Light
 LOCATION: off Federal Street/Parking Lots
 BOREHOLE NUMBER: 03-9
 DATE DRILLED: 6/18/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DEL MARVA Drilling
 DRILLER: Jeff Decarlo
 DRILLING METHOD: Hollowstem Auger
 HOLE DIAMETER: 6 3/8 in.
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: grassy areas

JOB NUMBER: 6527.103.01

LOCATION SKETCH



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
5	1	5/6	2/	3/4		Augered 5 ft med Brown fine to coarse sand sm. pebbles 1 1/2" med Brown very fine to silty sand, 2 1/2" med. Brown fine to med. grain, 6 1/2" med. Brown coarse grain, sm. pebbles, sand, 3 1/2" med. Brown med. to very coarse sand (sm. pebbles), 9 1/2" med. Brown fine to med. grain sand w/Black specks no particular odor
7	2	7/6	2/	3/4		6 1/2" med. Brown fine to med. sand w/Black specks - no particular odor, 1 3/4" med. Brown med. to very coarse sand w/Black specks no particular odor
9	3	9/6	2/	4/5		2" med. Brown med. sand, 8" med Brown very coarse sand w/sm. pebbles, black stains on pebbles and sand - no particular odor, 1 1/2" med Brown coarse sand w/Black specks near bottom of spoon
11	4	11/6	2/	4/3		2" Dk to med. Brown med. to coarse sand, 7 1/2" Lt. Brown med. to coarse sand, 2 1/2" Red Brown med. sand, (Dk. layer center) 1 1/2" med Brown coarse to very coarse sand
13	5	13/6	2/	3/3		Dk layer at 1 5/8" Dk specks throughout, no particular odor 3 1/2" med Brown med to coarse sand, 5 1/2" Lt. Brown med to coarse sand (some black specks), 2 1/2" Lt. Brown very coarse sand, pebbles (Dk specks) 3 1/2" Lt. Brown coarse sand, 1 1/2" Lt. Brown coarse sand, 9 1/2" med Red Brown med to coarse sand w/Black specks - no particular odor
15	6	15/6	2/	3/3		7 1/2" med Red Brown med to coarse sand, 1" very Dk Black Brown layer, 5" Red Brown med. sand, 1/2" Dk layer, 1 1/2" Brown red fine to med grain sand, 3 1/2" inches Dk Brown red fine to med. sand, 4" Red Brown fine to med. sand - roots
17						

HNU

5 ppm

1 ppm

5 ppm

1 ppm

1 ppm

1 ppm

Sampled

PAGE _____ OF _____

GEOLOGIST'S SIGNATURE

AR301301

GEOLOGIC LOG

JOB NUMBER: 6507.103.01

PROJECT: Dover Gas Light
 LOCATION: Btw. State + Armory Bldg. off William Penn St.
 BOREHOLE NUMBER: 03-10
 DATE DRILLED: 6/17/91
 FIELD REPRESENTATIVE: Juliana de la Jente
 DRILLING CONTRACTOR: DELMAR Drilling
 DRILLER: Jeff DECARLO
 DRILLING METHOD: Hollowstem Auger + Continuous Split
 HOLE DIAMETER: 6 5/8
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: grass

LOCATION SKETCH		
<u>William Penn Street</u>		
<u>State + Armory</u>		
<u>moved 03-10 2ft north</u>		
<u>State Bldg.</u>	<u>Parking Area</u>	<u>Armory Bldg.</u>

COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Augered to 5 ft. - no spoons collected. Cuttings: med. Brown fine silty sand dk. Brown med. sand Red Brown med. sand
5		5 ft. to 7 ft.	2/1	2/3		1'8" med. Brown fine silty sand to med. grain sand
7		7 ft. to 9 ft.	2/1	3/4		3 1/2" Lt. Brown fine to coarse sand, 1 1/2" tan med. to coarse sand, 2 1/2" Lt. Brown med. to coarse sand, 5 1/2" Lt. Brown fine to med. sand.
9		9 ft. to 11 ft.	2/1	3/8		1'1" Lt. Brown med. to coarse sand, 6" tan fine to med. sand, 5" Lt. Brown fine to med. sand
11		11 ft. to 13 ft.	2/1	6/8		5 1/2" Lt. Brown med. to coarse sand, 6 1/2" Lt. Brown fine to coarse sand, 2 1/2" Lt. Brown clay, 5 1/2" tan med. to coarse sand, 1" dk. Brown organic sand.
13		13 ft. to 15 ft.	2/1	4/3		3 1/2" Lt. Brown med. to coarse sand, 18 1/2" Red Brown fine to coarse sand.
15		15 ft. to 17 ft.	2/1	2/4		10" Red Brown fine to coarse sand, 5" Red Brown w/ dark organic like layers med. to very coarse sand, 3" Red Brown med. to coarse sand, 2 1/2" Lt. Brown coarse sand, 1 1/2" med. Brown fine to coarse sand.
17		17 ft. to 19 ft.	2/1	7/5		8" Red Brown med. to coarse sand, 2" Red Brown w/ some slight dk. layers med. to very coarse, 4" Red Brown (w/ pebbles) w/ dark bands has slight diesel odor, med. to very coarse, 2" Red Brown coarse sand w/ dark thick bands, 2" Red Brown very coarse sand - some dark layers.

NNU

Oppm

Oppm

Oppm

.5 ppm

.5 ppm

.7 ppm

1 ppm

GEOLOGIST'S SIGNATURE

PAGE _____ OF _____

AR301302

PROJECT: Dover Gas LIG NT

JOB NUMBER: _____

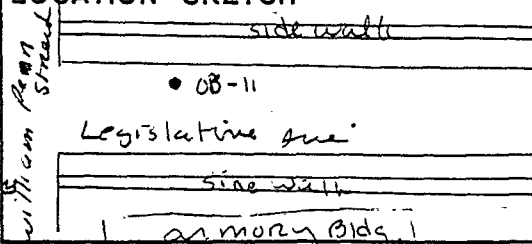
LOCATION: _____

BOREHOLE NUMBER: 08-11DATE DRILLED: 6/19/91FIELD REPRESENTATIVE: J. L. de la FuenteDRILLING CONTRACTOR: DEL MAR 4 DrillingDRILLER: Jeff De CarloDRILLING METHOD: Hollowstem Auger - Continuous Split SporeHOLE DIAMETER: 6 5/8"

GROUND ELEVATION: _____

CONDITION OF GROUND SURFACE: asphalt

LOCATION SKETCH



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Augered to 5 ft. - no spores collected cuttings: med. Brown fine to coarse sand - sm. pebbles LT. Brown fine to coarse sand musty / humic odor
5	1	5 to 7 ft	2	7/10		1' 0" LT. Brown fine to very coarse sand @ 5" dk. organic Band
7	2	7 to 9 ft	2	4/6		1' med. Brown med. to coarse sand (black specks in soil, 1, 3") LT. Brown med. to very coarse sand, 5" med. Brown med. to very coarse sand (sm. clay clumps in this section) 1/2" med. Brown med. to coarse sand, 1 1/2" med. Brown clay, 1" med. Brown med. sand
9	3	9 to 11 ft	2	3/4		2" LT. Brown med. to coarse sand, 9" med. Brown very fine silty sand to coarse sand, 3" Red Brown coarse sand, 2" Red Brown (pebbles) very coarse sand, 1 1/2" Red Brown very coarse sand 1 1/2" tan coarse sand, 1" LT. Brown coarse sand
11	4	11 to 13 ft	2	11/9		1 1/2" med. Brown silty to med. sand, 3 1/2" med. Brown med. sand, 2" med. Brown med. to coarse sand, 1" dk. Brown med. grain sand, 1" Red Brown very coarse sand, 1 1/2" med. Brown med. sand, 1/2" very coarse Red Brown med. sand, 1/2" tan fine to med. sand, 2" med. Brown coarse to very coarse sand, 3 1/2" med. Brown med. to coarse sand - some log very evident.
13	5	13 to 15 ft	2	6/8		1" med. Brown silty to med. sand, 5" med. Brown coarse sand, 5 1/2" Red Brown very coarse sand, 1" Red Brown fine to med. sand, 5 1/2" Red Brown med. to coarse sand, 1/2" dk. Brown coarse sand, 1 1/2" Red Brown med. to coarse sand.
15						

1 ppm

6 ppm

3 ppm

0 ppm

1 ppm

5 ppm

GEOLOGIST'S SIGNATURE _____

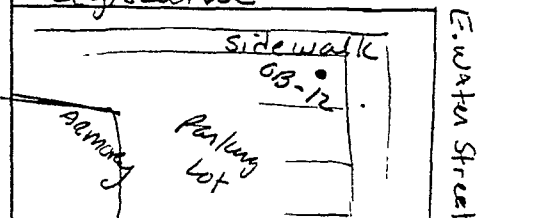
PAGE _____ OF _____

AR301303

PROJECT: Dover Gas Light
 LOCATION: Back Parking Area
 BOREHOLE NUMBER: OB-12
 DATE DRILLED: 6/18/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DELMARVA Drilling
 DRILLER: Jeff DeCarlo
 DRILLING METHOD: Hollow Stem Auger - Continuous Split
 HOLE DIAMETER: 6 5/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: asphalt

JOB NUMBER: 6527.103.01

LOCATION SKETCH



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Augered to 5 ft. - no spoons collected. Cuttings: med. Brown fine silty sand. Dk. Brown med. sand. Red Brown med. sand.
5	1	5 ft. 7 ft.	2 1/2" 1' 7"	5/7 7/4		4" Lt. Brown med to coarse grain sand, 3" Lt. Brown med to very coarse sand (sm. pebbles), 4 1/2" Lt. Brown fine to med. grain sand, 2 1/2" med. Brown med grain sand. 5 ppm
7	2	7 ft. 9 ft.	2 1/2" 1' 7"	6/9 14/5		2 1/2" Lt. Brown med. sand, 1/2" Dk. Black layers, 1/2" med. Dk. Brown fine to med sand, 1 1/2" Red Brown fine to very coarse sand. Dk layers at 11", 12", 14 1/2", 16 1/2". 5 ppm
9	3	9 ft. 11 ft.	2 1/2" 11"	6/9 14/5		11" Tan coarse to very coarse sand (sm. pebbles). Dk. Bands/layers at 1", 2 1/2", 3", 6", 6 1/2", 7 1/2". 2.5 ppm
11	4	11 ft. 13 ft.	2 1/2" 1' 4 1/2"	13/12 13/14		1" med. Brown fine silty sand, 1" sm. grt. rock, 1" Lt. Brown fine to med. grain sand, 7 1/2" Red Brown med to coarse grain sand, 6" Red Brown very coarse sand. Dk stained layer at 11". 2 ppm
13	5	13 ft. 15 ft.	2 1/2" 1' 7"	2/5 3/5		9" Red Brown coarse to very coarse sand, 1" med. Brown coarse sand, 1/2" stained med. sand, 1 1/2" grey clay w/ red banding. has some blk stained layers, 1/2" Red Brown coarse sand, 6 1/2" grey clay w/ red thin layers. 2.7 ppm
15	6	15 ft. 17 ft.	2 1/2" 1' 9 1/2"	2/5 6/8		2" med. Brown fine to med grain sand, 1/2" grey w/ red layers clay, 3 1/2" grey/red clay + Red Brown med. grain sand, 1 1/2" grey clay w/ red layers, 1/2" Red Brown fine to med sand, 2 1/2" med. Brown fine to coarse sand (sm. layers of clay), 6" grey/red clay, 1 1/2" med. Brown/red Brown coarse grain sand (Dk. layers of staining), 1/2" clay (grey), 1" Lt. Brown very coarse sand, 1/2" stained black coarse sand. 2.0 ppm

GEOLOGIST'S SIGNATURE _____

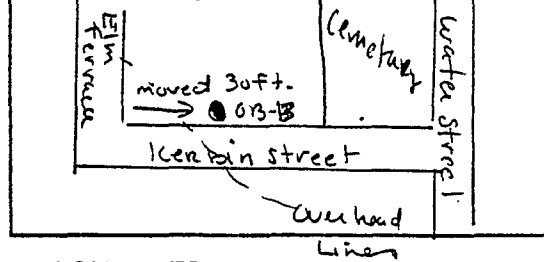
PAGE _____ OF _____

AR301304

PROJECT: Dover Gas Light
 LOCATION: Kabin Street - church property
 BOREHOLE NUMBER: OB-13
 DATE DRILLED: 6/14/91
 FIELD REPRESENTATIVE: Julian de la Torre
 DRILLING CONTRACTOR: DELMARVA
 DRILLER: Jeff DeCarlo
 DRILLING METHOD: Hollowstem auger/split spoon
 HOLE DIAMETER: _____
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: grassy

JOB NUMBER: 6527.103.01

LOCATION SKETCH



COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Drilled 5 feet - cutting med Brown sand, fine to coarse grain w/ some small pebbles
5	1	5.6 ft	2/110	7/8		1 1/2" Tan fine to coarse grain sand w/ dark specks especially near the bottom
7	2	7.16 ft	2/110	5/5		3 1/2" Tan med to coarse sand, 2" dk Brown med sand, 2" lt Brown med to coarse grain sand, 5" Tan med sand, 4" lt Brown med to fine sand, 5" lt Brown fine to med sand, 8" Tan fine to med sand, 1/2" med Brown fine to med sand
9	3	9.6 ft	2/110	6/5		3 1/2" Tan fine to med grain sand, 1/2" Red Brown med sand, 2" Tan fine to med sand, 1/2" small pebbles, 3" Tan coarse grain sand, 2" lt Brown med to coarse grain sand, 5" med Brown fine to med sand, 5" Red Brown fine to coarse sand, 1" Tan very coarse sand
11	4	11.6 ft	2/110	3/4		10 1/2" Tan very coarse sand, 3 1/2" Rust med to coarse grain sand, 5" Tan coarse grain sand
13	5	13.70 ft	2/110	29/40		3" Red Brown coarse sand, 1/2" grey clay w/ Red thin layers, 2 1/2" Tan very coarse sand, 3" Tan coarse to very coarse sand, 1" Red Brown med to coarse sand, 8" Tan very coarse sand w/ small pebbles
15	6	15.76 ft	2/110	20/32		2" dk Brown coarse sand, 8" Tan coarse to very coarse sand, 1/2" Dark Brown coarse sand, 1 1/2" Tan very coarse sand
17	7	17.16 ft	2/110	6/11		4 1/2" Tan med to coarse grain sand, some slight discoloration, 4" Red Brown coarse sand, 3" light Brown coarse sand - some slight clay layers, 5 1/2" Red Brown coarse sand, slight odor

HNU

0 ppm

1 ppm

3 ppm

3 ppm

5 ppm

5 ppm

sampled 19

GEOLOGIST'S SIGNATURE _____

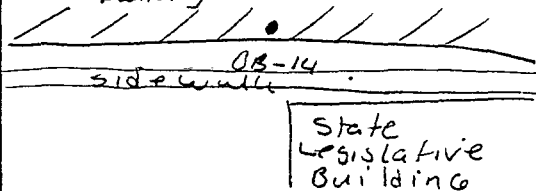
PAGE _____ OF _____

AR301305

JOB NUMBER: 65 27 103.01

PROJECT: Dover Gas Light
 LOCATION: _____
 BOREHOLE NUMBER: OB-14
 DATE DRILLED: 6/17/91
 FIELD REPRESENTATIVE: Juliana de la Fuente
 DRILLING CONTRACTOR: DEL MARVA Drilling
 DRILLER: JEFF DE CARLO
 DRILLING METHOD: Hollow Stem Auger continuous split spoon
 HOLE DIAMETER: 6 5/8"
 GROUND ELEVATION: _____
 CONDITION OF GROUND SURFACE: Asphalt

LOCATION SKETCH

Representative
Parking

COMMENTS: _____

DEPTH	NUMBER	INTERVAL AND TYPE	ADVANCED/ RECOVERED	BLOW COUNTS PER 6 INCHES	WATER TABLE	SAMPLE DESCRIPTION (SOIL OR ROCK TYPE, COLOR, GRAIN SIZE, SORTING, ROUNDNESS, PLASTICITY, MOISTURE CONTENT, TRACE MATERIALS, ODOR, STAINING, TRACE GAS READINGS)
						Augered to 5 ft. - no specimens collected
						Cuttings: med brown silty to med sand w/ pebbles small to med.
5	1	5 to 7 ft	2/19"	5/7		2" DK. Red Brown fine to med. sand, 4" med. Brown coarse sand, 10" Lt. Brown coarse to very coarse sand, 1 1/2" Lt. Brown fine to med. sand, 1 1/2" grey clay, 1/2" med. Brown coarse sand, 1 1/2" clay.
7	2	7 to 9 ft	2/2"	3/4		2" DK. organic soil med. sand, 10" Red Brown very coarse sand, 6" DK. Brown coarse sand, 6" DK. Red Brown med to coarse grain sand.
9	3	9 to 11 ft	2/2"	3/3		1" DK. organic fine grain sand, 6" Red Brown fine to med sand w/ DK. organic material, 2 1/2" DK. Brown fine to med sand, 1 1/2" Red Brown coarse sand, 2" organic material, 3" Red Brown coarse sand.
11	4	11 to 13 ft	2/10"	3/2		12" Red Brown coarse sand w/ some DK. specks, few lumps, 10" Red Brown coarse sand.
13	5	13 to 15 ft	2/15"	6/7		2 1/2" in. Red Brown med to coarse sand, 1/2" organic layer, 2 1/2" med. Brown med to very coarse sand, 1 1/2" med. Brown coarse sand w/ some black specks, 2" med. Brown med. to coarse sand, 1 1/2" DK. Brown med. to coarse sand, 4 1/2" Red Brown med to coarse sand.

NVA

0 ppm

5 ppm

0 ppm

0 ppm

0 ppm

GEOLOGIST'S SIGNATURE

PAGE _____ OF _____

AR301306

GEOLOGIC LOG

Dover Gas Light Site Borehole Number 6C 08/01/91			Driller: Ken DeRoche, Delmarva
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Description
1	0-2	2/1 -	3" damp gray to brown sandy silt (fill) trace asphalt grades to orange sandy silt with roots, gravel and clay, firm, dry, no odors. HNu=1.0
2	5-7	2/1	Tan to orange medium coarse sand with clay/silt band at 6", trace gravel, very slightly damp, no odor, silt/clay stiff and firm, sand well sorted and subrounded. HNu= <1.0
3	10-12	2/1	Orange-tan, medium to coarse sand with trace white to orange clay stringer, brown iron staining, sand is rounded to subrounded, moderately well sorted, slightly damp, no odors. HNu=0.0
4	15-17	2/2	2" orange medium to coarse sand, wet, no odors, iron stained with brown hematite, white clay and coarse gravel in wash from above. HNu=0.0
5	20-22	2/2	Orange-tan medium sand, trace coarse sand and angular to subrounded gravel, wet, no odors. HNu=0.0
6	25-27	2/0	No recovery, no odors. HNu=0
7	30-32	2/2	White and orange layered medium to fine sand, wet, very faint coal tar-like odor. Very faint coal tar-like odor in borehole. HNu=<0.0
8	35-37	2/8	Orange-tan medium sand, wet, no odors, 6" wash from above. HNu=<0.0
9	40-42	2/6	No recovery - wash gravel from above. Driller reports clay at 43', dark brown-gray. HNu=<0.0
10	45-47	2/2	Dark gray compact silt and fine sand laminated, micaceous. End of spoon has orange sand and silt. Coal tar-like odor, oily in gray silts. 3-4" silt/clay on top of spoon followed by sand. HNu=>50 ppm
11	47-49	2/6	No recovery, 6" gravel and clay lumps from above, coal tar-like odor in gravel.
12	50-52	2/1.2	6" wash from above. 8" orange fine sand, wet, coal tar-like odor, no streaks. HNu=7 ppm
13	55-57	2/1	Gravel wash from above, coal tar-like odor. Driller reports confining layer at 58'.

DRAFT

GEOLOGIC LOG

Dover Gas Light Site Borehole Number 6C 08/01/91		Driller: Ken DeRoche, Delmarva	
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Description
14	60-62	2/1	Gray silt and fine sand laminated, still dry, compact, slightly coal tar-like odor, similar to compact layer at well 10c. HNu=<2
15	62-64	2/2	Gray compact silty clay and fine sand, laminated. Dry, firm, no odors. Stiff. HNu<0
16	64-66	2/1.4	1.3' gray, clayey silt trace fine sand (stringers), no odor, stiff, slightly damp. 1" fine gray sand in end of spoon. Silts are laminated with fine quartz sand. HNu=0.0
17	70-72	2/2	Dark gray clay and silt, moderately stiff, wet, plastic, slippery, no odors, trace fine quartz sand, laminated. Driller reports 1' clay at 73'. HNu=0.0
18	75-77	2/8"	Dark gray fine sand with interbedded compact gray silt, stiff where silty, damp, no odors, sand in end of spoon. Driller reports sand - 78'-79'. HNu=<1
19	80-82	2/0	No recovery - gravel wash from above.
20	82-84	2/2	Light gray fine and medium sand trace silt damp, no odors, silt in layers. HNu=<1
21	90-92	2	Lightly gray interbedded silt and fine sand, dry, stiff where silty.

Note: Driller reports orange clay 28'+

Geologist: 

AR301308

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW7C 07/12/91				Driller: Ken DeRoche, Delmarva
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Description	
1	0-2	2/1	Gray-brown medium sand and some silt, slightly damp (fill) trace fine gravel, asphalt in top of spoon and gravel, no odor. HNu=Background (BG)	
2	5-7	2/1	1' orange-tan medium sand, no odor, trace iron staining with 4" wash from above. HNu=BG	
3	10-12	2/2	1.5' wash from above, 2" tan coarse gravel with some medium sand, 2" gray medium sand, no odors. 4" orange clay with trace fine sand, no odors. HNu=4 in gravel zone above the clay.	
4	15-17	2/8"	8" dark gray silty fine sand, slightly plastic, damp top soil odor (no coal tar), old soil profile. HNu=BG	
5	20-22	2/2	1.5' wash from above. 6" brown medium sand, some orange iron stains, wet, no odor. HNu=BG	
6	25-27	2/2	1' wash from above. 1' orange to white medium to coarse sand. Some white clay interbedded, also trace coarse subrounded gravel. HNu=BG	
7	30-32	15"/6"	1" wash, 6" tan medium to coarse sand and gravel, iron stains, wet, no odor. HNu=BG	
8	35-37	2/6"	6" wash, 6" tan medium to coarse sand, some rounded gravel, wet, no odor. HNu= 2.0	
9	40-42	2/6"	3" wash, 3" light tan medium to fine sand, some gravel, no odor, damp, trace iron staining. HNu= BG	
10	45-47	2/1	10" wash, 2" orange clay with some medium sand and gravel, damp, no odor. HNu=3.0	
11	50-52	2/1	2" wash, 10" dark gray compact silt/clay trace fine sand, no odor, laminated, stiff, slightly plastic. HNu=3.0	
12	55-57	2/2	2' dark gray compact silt/clay, laminated, trace fine sand, stiff, slightly plastic, coarsen downward. Set surface casing to 55'. HNu=BG	
1	60-62	2/18"	3" gravel wash, 15" dark green-olive silt, some fine sand. HNu=<5 ppm	

DRAFT

GEOLOGIC LOG

Dover Gas Light Site
Borehole Number MW7C
07/12/91

Driller: Ken DeRoche, Delmarva

Sample Number	Interval (feet)	Advanced/ Recovered (feet)	Description
2	65-67	2/2	1' gravel wash, small recovery, possible gravel layer. HNu=<5 ppm
3	70-72	2/1	2" gravel wash, start Frederica sand, fine grained, gray-green. HNu=0 ppm
4	75-77	2/1	Frederica sand. HNu=3 ppm
5	80-82	2/1	Frederica sand. HNu=3 ppm

Note: TD - 82' set screen.

Geologist: 

DRAFT

GEOLOGIC LOG

Dover Gas Light Site Borehole Number 10C 07/18/91		Driller: Ken DeRoche, Delmarva	
Sample Number	Interval (feet)	Advanced/ Recovered (feet)	Description
1	0-2	2/18"	6' humus with grass, 12" sand - medium gravel, tan color. HNu=8 ppm
2	5-7	2/8"	8' Columbia sand, wet, no odor. HNu=30 ppm
3	10-12	2/8"	8' Columbia sand. HNu=30 ppm
4	15-17	2/18"	3" gravel wash, 15" Columbia sand. HNu=15 ppm
5	20-22	2/1	Columbia sand. HNu=3 ppm
6	25-27	2/2	3" gravel, 21" Columbia sand. HNu=2 ppm
7	30-32	2/16"	2' gravel, 13" Columbia sand. HNu=2 ppm
8	35-37	2/1	4" gravel wash, 8" Columbia sand. HNu=Background (BG)
9	40-42	2/5"	3" gravel wash, 10" Columbia sand. HNu=BG
10	45-47	2/8"	2" gravel, 6" Columbia sand. HNu=BG
11	50-52	2/13"	3" gravel, 10" Columbia sand. HNu=BG
12	55-57	2/20"	Columbia sand, 12" very coarse - 3" medium to fine gravel sand. HNu=BG
13	60-62	2/22"	2" gravel sand, 20" blue-green silt. HNu=BG
14	65-67	2/2	silt unit.
15	70-72	2/2	silt unit.
16	75-77	2/2	Frederica sand.
17	80-82	2/2	Frederica sand.
18	85-87	2/2	Frederica sand.
19	90-92	2/2	Frederica sand.

Note: Set surface casing at 62' BGS.

Geologist: 

GEOLOGIC LOG

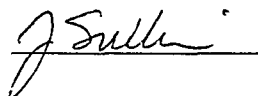
Dover Gas Light Site Borehole Number MW11C 06/26/91				Driller: Ken DeRoche
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
1	0-2	2/14"	9,9,10,7	6" brown, medium grained sand (top soil), 8" black, rust, cinders, stone, no odor. HNu=0.0
2	2-4	2/6	6,3,1,1	Road debris, glass, stone, no odor. HNu=0.0
3	4-6	24/0	1	No recovery, some cinders.
4	6-8	24/15"	2,1,1,12	6" cinders, rust, trash, glass, 6" dark brown, fine sand, silt, plant material, no odor, 3" well sorted, light gray to white, medium grained sand. HNu=0.0
5	8-10	2/1	2,1,1,2	6" slough, cinders, etc., 6" light gray to white, fine grained, poorly sorted, sand, pebbles present.
6	10-12	24/3"	1,1,1,6	Medium to fine grained, light gray sand, no odor. HNu=0.0
7	15-17	2/1	5,16,21,32	8" very coarse grained, poorly sorted, sand light gray to white, sand, 4" brown, medium grained sand, orange-brown mottled. No odor. HNu=0.0
8	20-22	2/20"	14, 19, 22,24	10" light tan, medium to coarse grain, well sated sand, 2" layer of debris, pebbles, 10" orange-brown mottled medium to coarse grained sand, no odor. HNu=0.0
9	25-27	2/1	5,12,30,31	5" slough, 7" orange-brown, medium grained, well sorted sand, no odor. HNu=0.0
10	28-29	2/2	23,25,80	80/3", very coarse grained pebble-rich brown sand, no odor. HNu=0.0
11	29-31	24/6"	55,55,52,26	All coarse debris, cinders, etc., hard driving in slough.
12	35-37	NA	21	21 counts for 6" - slough, grit, glass, etc.
13	45-47	2/2	1	24" of chocolate brown, clay with gray silt, laminae, no odor. TD at 51'. Driller noted gravel in cuttings, coarse to coarse gravel sand. HNu=0.0

DRAFT

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW11C 06/26/91				Driller: Ken DeRoche
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
14	61-63	2/2	NA	Banded dark gray, fine sand and silt, very slightly damp, no odor, slightly plastic. Driller reports sand zone, confirmed by checking bag sample from #11D.
15	74-76	2/8"	NA	Dark gray fine sandy silt, wet, stiff, plastic, no odors.

Geologist:



GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW11D 06/26/91				Driller: Ken DeRoche
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
1	0-2	14/2"	9,9,10,7	6" brown - medium grained sand - top soil, 8" black, rusted, asphalt and stone.
2	2-4	8/2	- 6,3,1.5,1	More road debris, glass, stones 6", no odor.
3	4-6	0/2	1	No recovery, some cinders, no odor. HNu=0.0
4	6-8	18/2	2,1,1,12	6" more cinder, rust, trash, glass, 6" dark brown, fine sand/silt plant material, no odor. 6" well sorted light gray to white sand medium grained. HNu=0.0
5	8-10	1/2	2,1,1,1	6" slough, 6 light gray to white medium grained poorly sorted sand, pebbles present.
6	10-12	3/2	1,_,_,6	Medium to coarse grained sand light gray, no odor, HNu=0.0
7	15-17	1/2	5,16,21,32	8" very coarse grained pebbly sand, light gray to white, 4" brown medium grained sand, Columbia, rusted, no odor. HNu=0.0
8	20-22	20/2	14,19,22,24	10" light tan, medium to coarse grained, well sorted sand, 2" layer debris, quartz pebble, glass, pottery, 10" orange brown mottled, medium sand, no odor. HNu=0.0
9	25-27	1/2	5,12,30,31	5" slough, 7" medium grained, well sorted orange/mottled sand, no odor. HNu=0.0
10	27-29	2/2	23,25,80,_	Major refusal - 80/3", very coarse grained pebble rich brown sand.
11	29-31	NR	35,55,52,26	Very hard driving. No recovery.
12	35-37	NR	21,6	21 counts for 6". No recovery.
13	45-47	NR	NR	24" of chocolate brown, clay gray silt _____ up to 0.5" thick. TD at 50'.

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW11D 06/26/91				Driller: Ken DeRoche
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
14	55-57	2/2	ND	6" collapse, 1.5' gray silty clay, laminated slightly plastic, trace fine sand dry, no odor. HNu=0.0 Background (BG)
15	60-62	2/2	ND	4" collapse, 1.8' gray clay with laminated silt and fine sand, worm burrows. Dry firm, nonplastic to slightly plastic, no odors. HNu=0.0 (BG)
16	65-67	2/2	ND	2' dark gray, wet, medium to fine quartz sand with trace coarser angular quartz and trace clay shells. Some lamination, no odors. HNu=BG
17	70-72	2/2	ND	6" slough from above, 1.5' dark gray, medium to fine quartz sand some clay, wet, no odor (see above), some angular coarser quartz fragments.
18	75-77	2/2	ND	2' dark gray, fine sand and clay, drier than above, slightly plastic, no odor, some laminated. HNu=BG
19	80-82	2/2	ND	2' dark gray, fine sand and clay, silicon clays, slightly plastic, some lamination, angular gray sand fragments. HNu=BG
20	85-87	2/2	ND	2' dark gray (fine) sandy clay with shell fragments, slightly plastic, wet, no odor, no lamination. HNu=BG
21	90-92	2	ND	6" dark gray, silty sand with 50% pink colored shell, wet, no odor, compact. HNu=BG
22	95-97	2/1.2	ND	4" dry dark gray clay with fine sand, 7" gray fine sand and peach-colored shell, wet, no odor, 5" dry silty clay, dark gray, trace shell, no odor. HNu=BG
23	100-102	2/1	ND	1' light gray, medium to fine quartz sand with pink shell. Driller reports hard sand, wet, no odors, trace clay. HNu=BG
24	105-107	2/5	ND	5" light gray medium sand (to fine) with pink shell, wet, no odor. HNu=BG

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW11D 06/26/91				Driller: Ken DeRoche
Sample Number	Interval (feet)	Advanced/ Recovered (feet)	Blow Counts/ 6 inches	Description
25	110-112		ND	No spl - washed out, gray sand and pink shell, 4" pink shell washed in from above. HNu=NR
26	115-117	2/1	ND	Dark gray, fine sand with some pink shell and trace clay, damp, compact, no odors. HNu=BG
27	120-122	2/2	ND	Dark gray, fine sand, trace clay, 40% pink shell, some clays, compact, no odors (spoon overdrive). HNu=NR
28	125-127	2/1.5	ND	Dark gray, fine sand, trace clay/silt, 30% pink shell, damp, no odors. HNu=NR
29	130-132	2/1.5	ND	Dark gray, fine sand, trace clay/silt, <5% pink shell, wet, no odors. HNu=NR
30	135-137	2/2	ND	Dark gray, fine sand trace clay, wet, 25% pink shell, no odors. Driller reports water losses. HNu=NR
31	140-142	2/1.5	ND	Dark gray, fine sand and some clay, trace coarse sand and fine gravel and pink shell. 1 fragment fibrous shell (see photo #6), damp, no odors. HNu=NR
32	145-147	2/5"	ND	Light gray, medium to coarse quartz sand, trace shell and rounded gravel and wood fragments, wet. Rig chatter during drilling. HNu=NR
33	150-152	2/6"	ND	Light gray, medium to coarse quartz sand, wet, no odors, black fines layer, trace rounded gravel. HNu=NR
34	155-157	2/2	ND	Light gray, medium to coarse sand, trace rounded gravel, trace shell, 1 white clay stringer (<1cm). Low recovery. Drill chatter. HNu=NR
35	167-169	2/2	ND	Medium gray, medium to coarse quartz sand, trace black fines. HNu=NR

Geologist: _____

6527LOGS.107_DOVER_GROUND-WATER_JS_SRS

AR301316


DRAFT

GEOLOGIC LOG

Dover Gas Light Site Borehole Number 12A 08/02/91			Driller: Jeff DiCarlo, Delmarva	
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
1	11-13	2/1.2	7,5, 5,4	Orange-brown, medium to coarse silty sand with iron stains, trace gravel on 1 cobble. Dry, no odors.
2	13-15	2/1.5	3,5,6,8	Orange-brown, medium to coarse sand, some silty, trace gravel. Iron concentrations, dry, no odors.
3	15-17	2/1.5	5,5,2,7	Orange-brown, coarse sand, some silt, iron stained and concentrations, no odors, damp in end of spoon.

Note: See log for 12C for further information. Drilled total depth = 26'.

Geologist:



DRAFT

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW12C 07/23/91			Driller: Ken DeRoche
Sample Number	Interval (feet)	Advanced/ Recovered (feet)	Description
1	0-2	2/13"	Top of spoon coarse gray fill. Below this brown-orange silty clay.
2	5-7	2/14"	Moist, orange-brown, poorly sorted, very fine to coarse sand.
3	10-12	2/16"	Orange-brown, medium coarse sand with some cobbles.
4	15-17	poor	Orange-brown coarse sand with black and clear quartz. Last 2" angular and rounded cobbles.
5	20-22	2/2	3" of poorly sorted brown-orange medium v. coarse sand, 3-4" of gray-tan mottled clay. Remaining medium coarse sand.
6	25-27	2/10"	Dark gray, fine sand and silt with some clay (gravel wash).
7	30-32	2/2	Dark gray, fine to medium sand with silt.
8	35-37	2/22"	Poorly sorted brown coarse sand (gray tint) (gravel wash).
9	40-42	poor	2 spoons taken cobble (wash?).
10	45-47		Grayish tan coarse sand.
11	50-52	2/1	Cobbles in fine to coarse sand matrix. Last 8" fairly well sorted, medium to coarse tan sand.
12	55-57	NR	Same as above.
13	60-62	poor	Dark gray silt to fine sand, coarse sand and cobble wash.
14	65-67	2/2	Chocolate brown clay with some silt.
15	90-92	2/21"	Silt unit. HNu=Background (BG)
16	75-77	2/20"	Silt with fingering of fine sands. HNu=BG
17	80-82	2/6"	Silt with fingering of fine sands. *Frederica sand at 83' BG. HNu=BG
18	85-87	2/18"	Frederica sand unit. HNu=BG

Note: Shelby tube taken - 67-69 feet.

Geologist: 

6527LOGS.107_DOVER_GROUND-WATER_JS_SRS

AR301318

DRAFT

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW13B 08/07/91			Driller: Ken DeRoche
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Description
1	30-32	2/0	No recovery - wash from above.
2	35-37	2/2	Gray, medium sand, some silt, trace clay, clays, coal tar-like odor. Some fine gravel. Not layered or laminated. HNu=5 ppm
3	40-42	2/6"	6" light brown, medium and coarse sand. Columbia, no odors, wet. HNu in wash above is less than 2.
4	45-47	2/4"	Light tan, medium sand, fairly well sorted, trace coarse sand and fine gravel, no odors, wet. HNu=5 max.
5	50-52	2/4"	Light tan, medium sand, fairly well sorted, trace coarse sand and fine gravel, no odors, wet, low recovery. HNu=0.0
6	55-57	2/4"	Light tan to grayish, medium to fine sand with sandstone cobbles, wet, no odors, low recovery. Driller reports gray silty clay at 59'. HNu=0.0
7	60-62	2/2	Dark gray, laminated clayey silt with trace lighter gray fine sand, firm, slightly plastic, trace fine sand in silt. HNu=0.0

Note: Columbia sand - 0-32 feet.

Geologist: 

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW15 04/01/91			Driller: Jeff DiCarlo, Delmarva	
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
1	10-12	2/2	2,2,2,1	Orange, medium to coarse sand, iron stained, FeO cement, slightly damp, no odors, no tar-like stains. OVA=0
2	12-14	2/2	1,1,1,2	1' orange, medium to coarse sand, wet, iron stains, trace gravel, grades coarser. 1' gray medium to coarse sand with fine gravel, black oil-like sheen. OVA=120
3	14-16	2/1	2,12,7,4	Black coarse sand with some fine to coarse gravel, oily, fuel (diesel) and tar-like odor, oil sheen, wet. OVA=14,24
4	16-18	2/1	1,2,5,10	Tan, silty coarse sand and fine gravel, 1/2" black streak @ 5", grades to orange, silty wet coarse sand with trace gravel, very light odor fuel, wet. OVA=0
5	18-20	2/2	8,5,3,3	Orange, silty coarse sand and gravel, wet. No tar stains, or odors. OVA=0
6	20-22	2/1.5	1,2,4,4	Orange, silty, medium to coarse sand, trace fine gravel, 2 brown FeO bands, wet, no odors, no stains (iron stained). OVA=0
7	22-24	2/2	3,20,17,7	1' wash from above, coarse sand and fine gravel, orange medium coarse sand, 1' white clay, 3" coarse gravel, silty coarse and medium sand, wet, silty, iron stained, 2" orange clay. OVA=0
8	24-26	2/2	3,2,2,3	1' orange, medium to coarse sand, trace silt, some fine and medium gravel, iron stained, wet, 1' light orange clayey sand, trace white clay stringers micaceous, damp to wet, no odors or stains. OVA=0
9	26-28	2	1,1,3,8	Orange, medium to coarse sand, subangular to subrounded, some clay with white clay stringers, variable quantities of clay, no odors or tar stains, micaceous, wet. OVA=0

GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW15 04/01/91			Driller: Jeff DiCarlo, Delmarva	
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
10	28-30	2/2	3,5,8,12	1' orange, silty, medium to coarse sand, subrounded, wet, grades into 1' white/light tan quartz medium sand, well sorted, subrounded, black mica, wet, no odors, no tar stains. OVA=0
11	30-32	2/2	0,1,4,8	Pale orange to white quartz sand, medium to coarse, well sorted, trace black fines, black mica, wet, no odors, or tar stains, FeO stains. OVA=0
12	34-36	2/1	6,9,8,6	Tan and orange medium to coarse sand, iron stains and bands, FeO brown streaks, wet, 3" silty clay sand in bottom, orange, iron stains. OVA=no reading (NR)
13	39-41	2/1.5	3,6,4,54	2" orange soft clay with trace sand, 1.3" medium to coarse silty sand with fine gravel, no odors, wet. OVA=0
14	44-46	18/1	6,29,50+	Orange, medium to fine sand, wet, no odors, trace black fines (no stain), trace mica. OVA=0
15	46-48	1.5	11,35,50+	10" orange, red medium sand, grades to 4" coarse sand, grades to medium fine sand, wet, no odors, few black streaks, no tar, from fines.
16	48-50	2/10	15,36,42,30	Limited recovery, washed out, orange-red, medium sand, grades to fine sand, trace fine gravel, wet, faint odor of tar? few black spots - fines? OVA=0.8
17	50-52	2/2	5,14,24,23	Light orange, medium sand, dark fines, wet grades to dark red-orange medium coarse sand and fine gravel, no odors, wet trace silt. OVA=1.0
18	52-54	2/17	9,15,17,16	Orange coarse sand and fine gravel grades to medium dark red-orange sand with FeO cement and trace medium gravel black streaks - fines, no odors. OVA=4.2

DRAFT

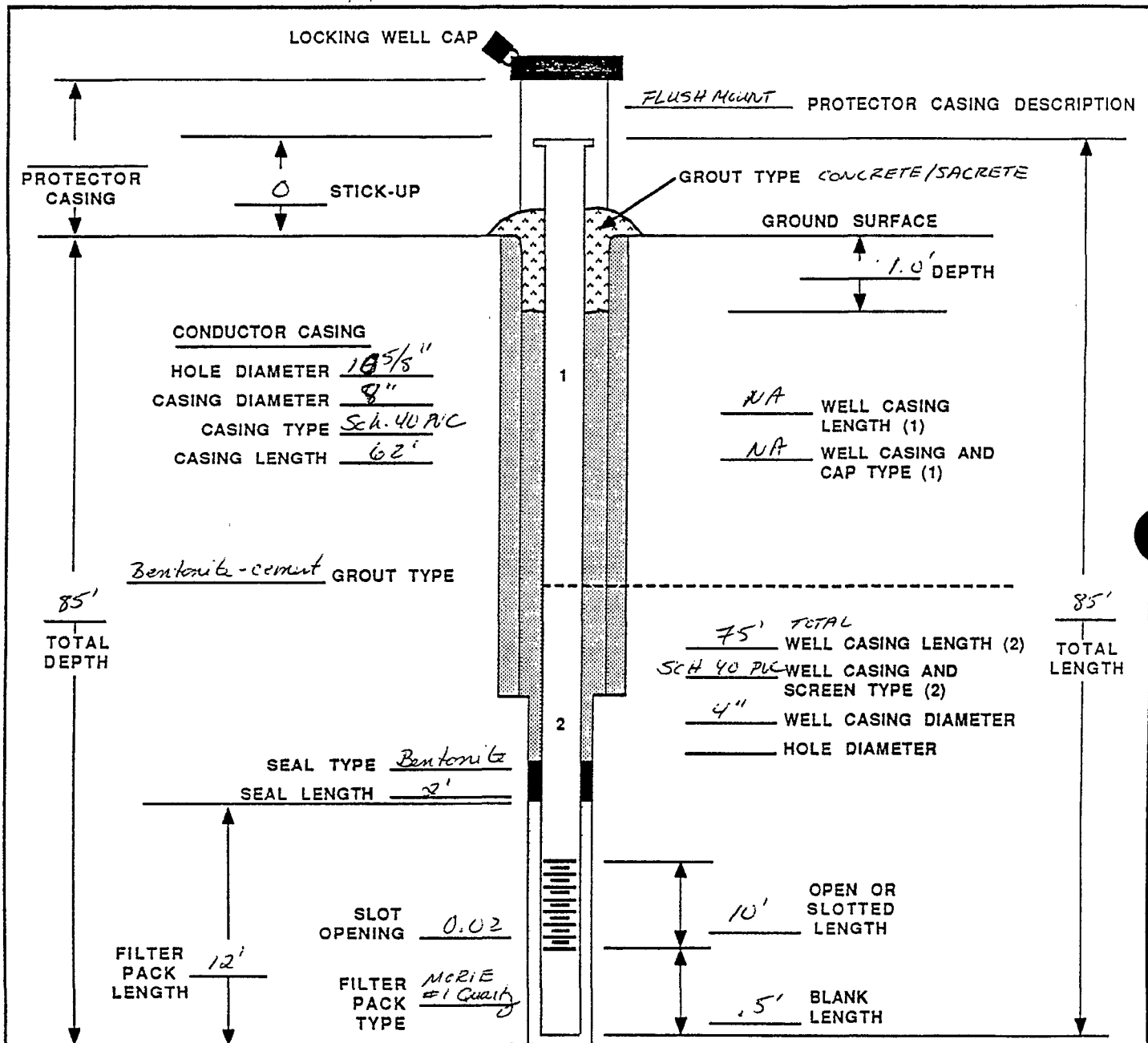
GEOLOGIC LOG

Dover Gas Light Site Borehole Number MW15 04/01/91			Driller: Jeff DiCarlo, Delmarva	
Sample Number	Interval (feet)	Advanced/Recovered (feet)	Blow Counts/6 inches	Description
19	54-56	2/2	15,22,37,54	1' orange, medium to coarse sand, coarsens down to fine gravel and sand, trace silt, no odors, 1' fragment fine sand, iron stains, wet. OVA=1
20	56-58	2/2	17,10,5,6	1' orange medium to fine sand with 2" coarse zone, no odors, 1' gray silt, stiff, slightly plastic, no odor, interbedded with very fine sands. OVA=1.6/0

Note: No samples 0-10 feet. Well set @ 25'.

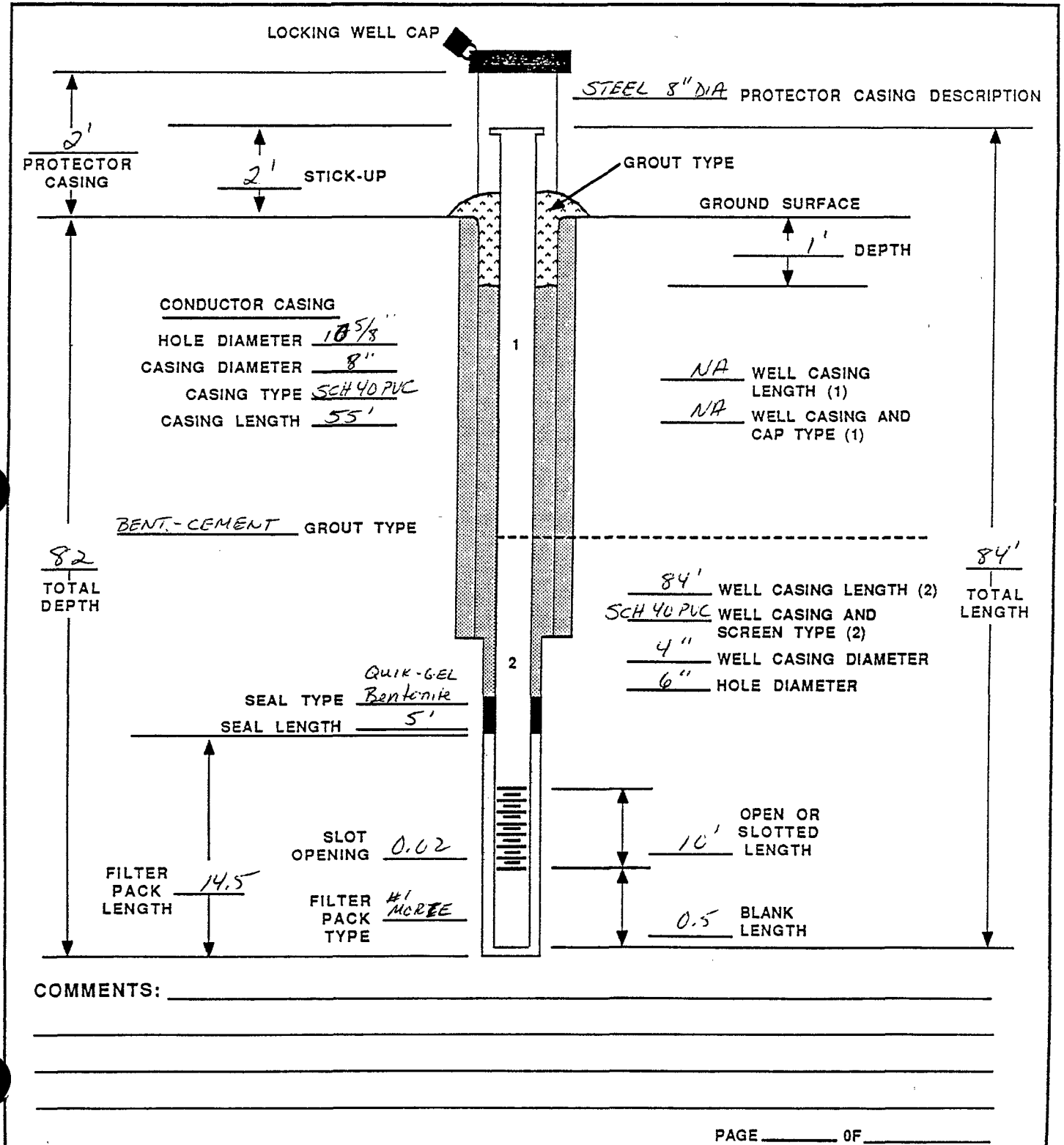
Geologist: 

PROJECT: DOVER GAS & LIGHT JOB NUMBER: 6527.106
 LOCATION: Parking lot behind Schmittinger & Rodriguez Law Offices
 WELL NUMBER: MW 6C ELEVATION: GROUND: 27.73'; CASING: 27.33'
 DATE INSTALLED: 8/1 - 8/5/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL

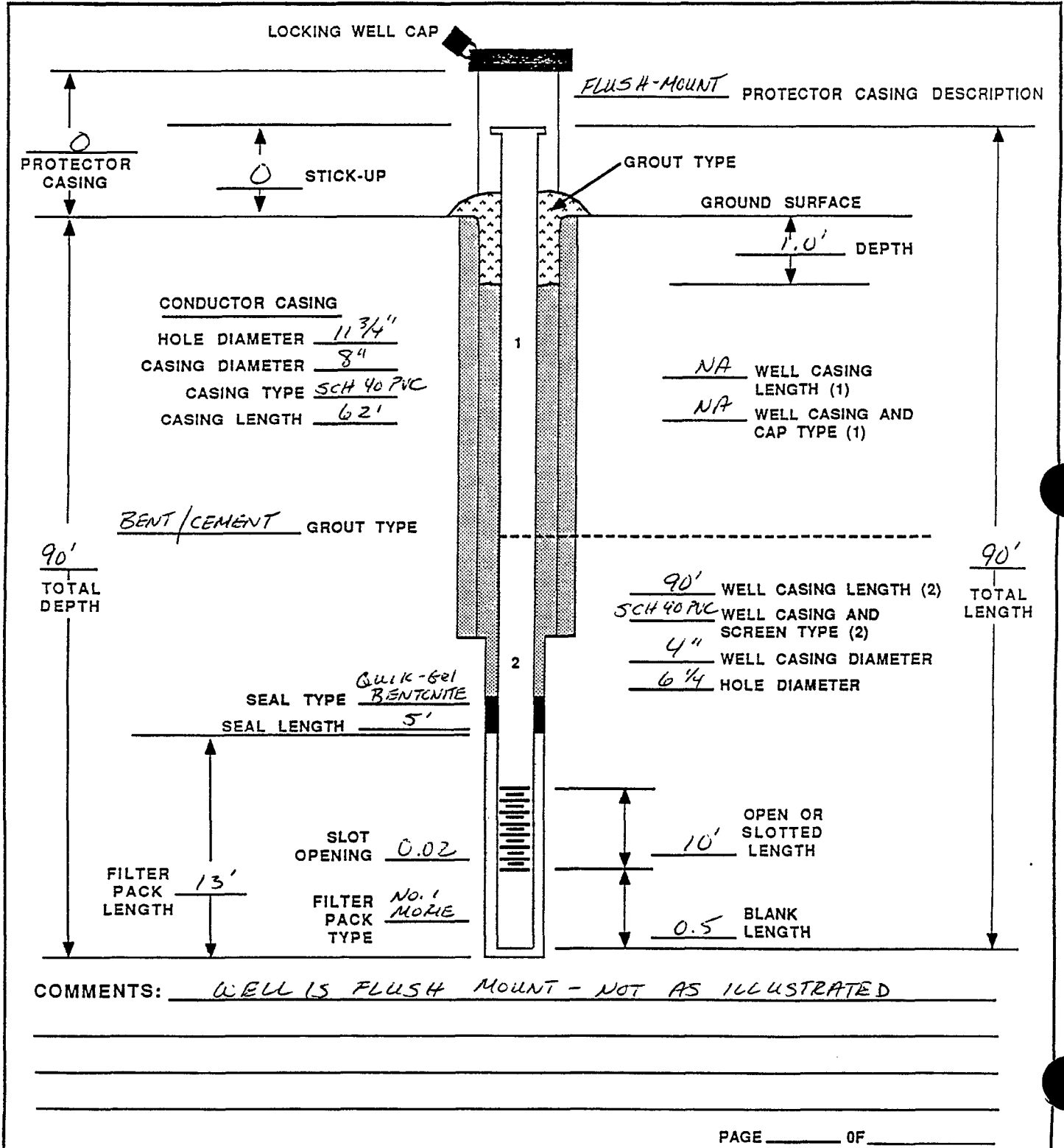


COMMENTS: This well is replacement for old MW 6C, Renamed MW 6B
Well has flush-mount cap, no stick-up as illustrated.

PROJECT: DOVER GAS LIGHT JOB NUMBER: 6527
 LOCATION: HOSPITAL - WEST PARKING LOT
 WELL NUMBER: MW 7C ELEVATION: GROUND: 16.12' ; CASING: 15.85
 DATE INSTALLED: 7/12 - 7/15/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



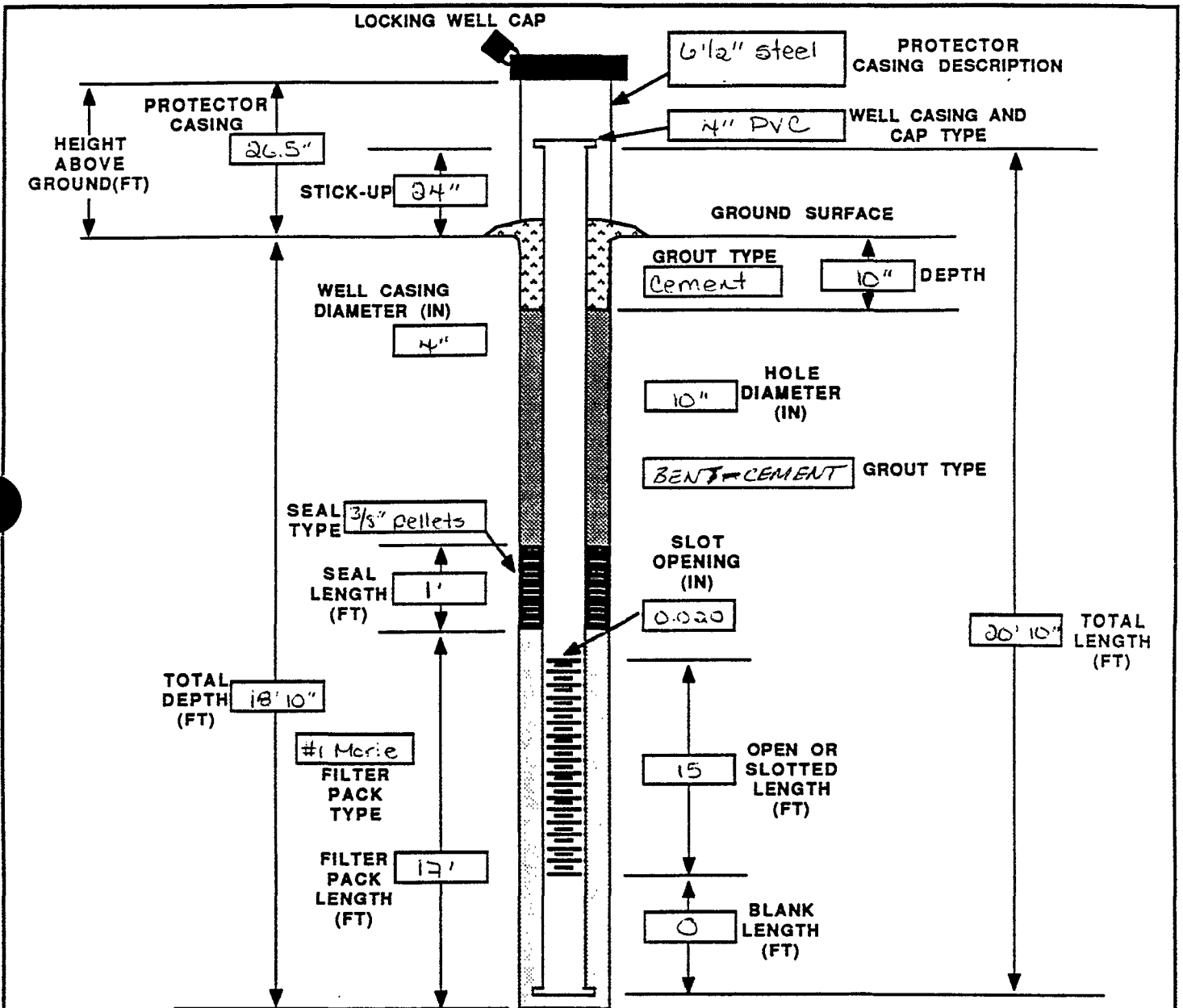
PROJECT: DOVER GAS LIGHT JOB NUMBER: 6522
 LOCATION: QUEEN ST AND NEW ST
 WELL NUMBER: 100 ELEVATION: GROUND: 26.30; CASING: 25.88
 DATE INSTALLED: 7/18 - 7/22/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☐ ABOVE MEAN SEA LEVEL



AR301325

WELL CONSTRUCTION DIAGRAM

PROJECT: Chesapeake Utilities JOB NUMBER: 6257.103
LOCATION: Oover DE - NEAR CITY SHOP AREA
WELL NUMBER: 11A ELEVATION: GROUND 8.70; CASING: 10.30
DATE INSTALLED: 7/16/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☐ ABOVE MEAN SEA LEVEL

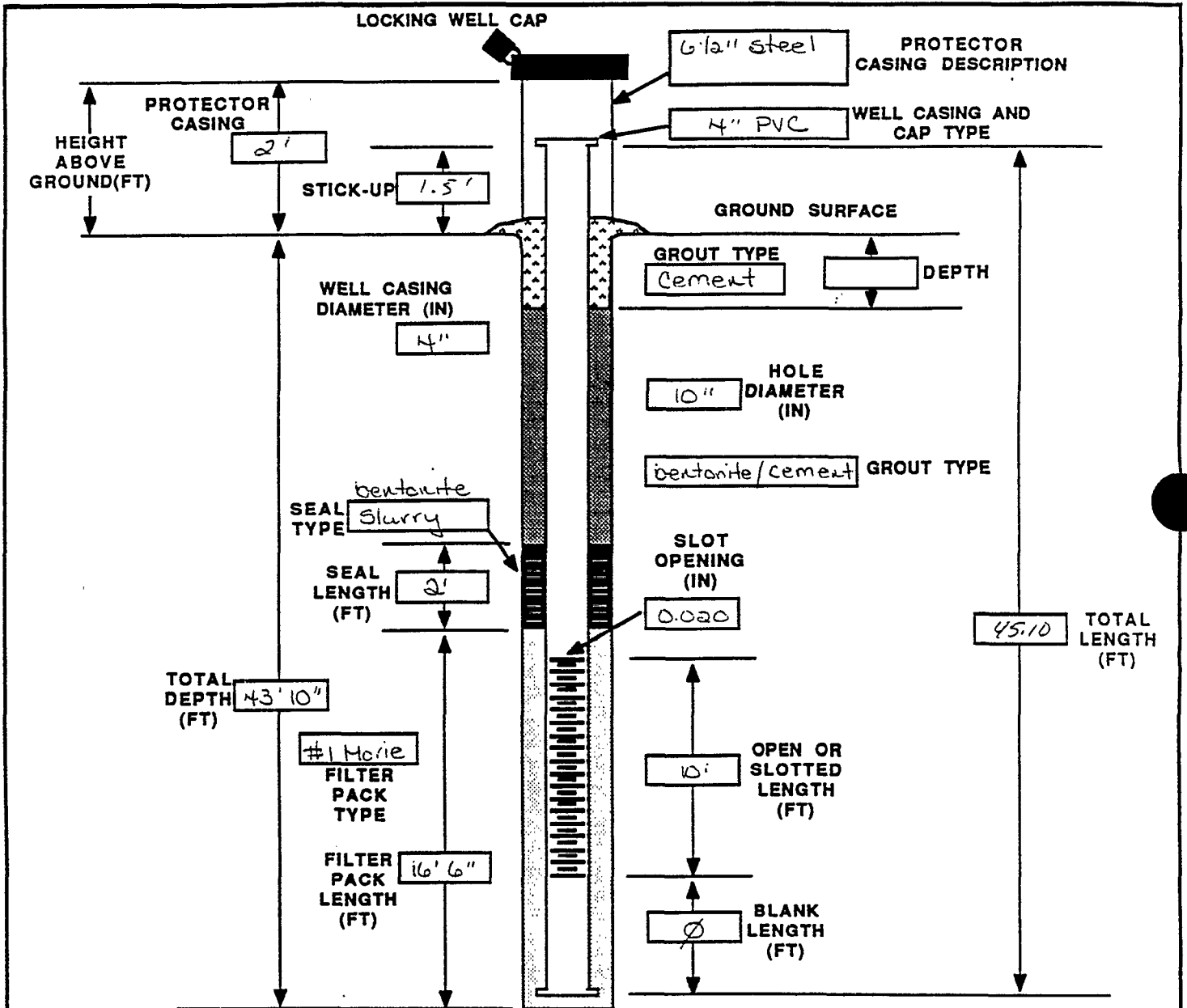


COMMENTS: Initial well development 2gals/min 7/16/91
Delmarva Drilling
Driller: Jeff DeCarlo
SEE WELL LOG FOR IIC OR IID FOR LITHOLOGY

AR301326

WELL CONSTRUCTION DIAGRAM

PROJECT: Chesapeake Utilities JOB NUMBER: 6257.103
 LOCATION: Dover, DE
 WELL NUMBER: 11B ELEVATION: GROUND: 10.38; 8.66 CASING
 DATE INSTALLED: 7/17/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☐ ABOVE MEAN SEA LEVEL

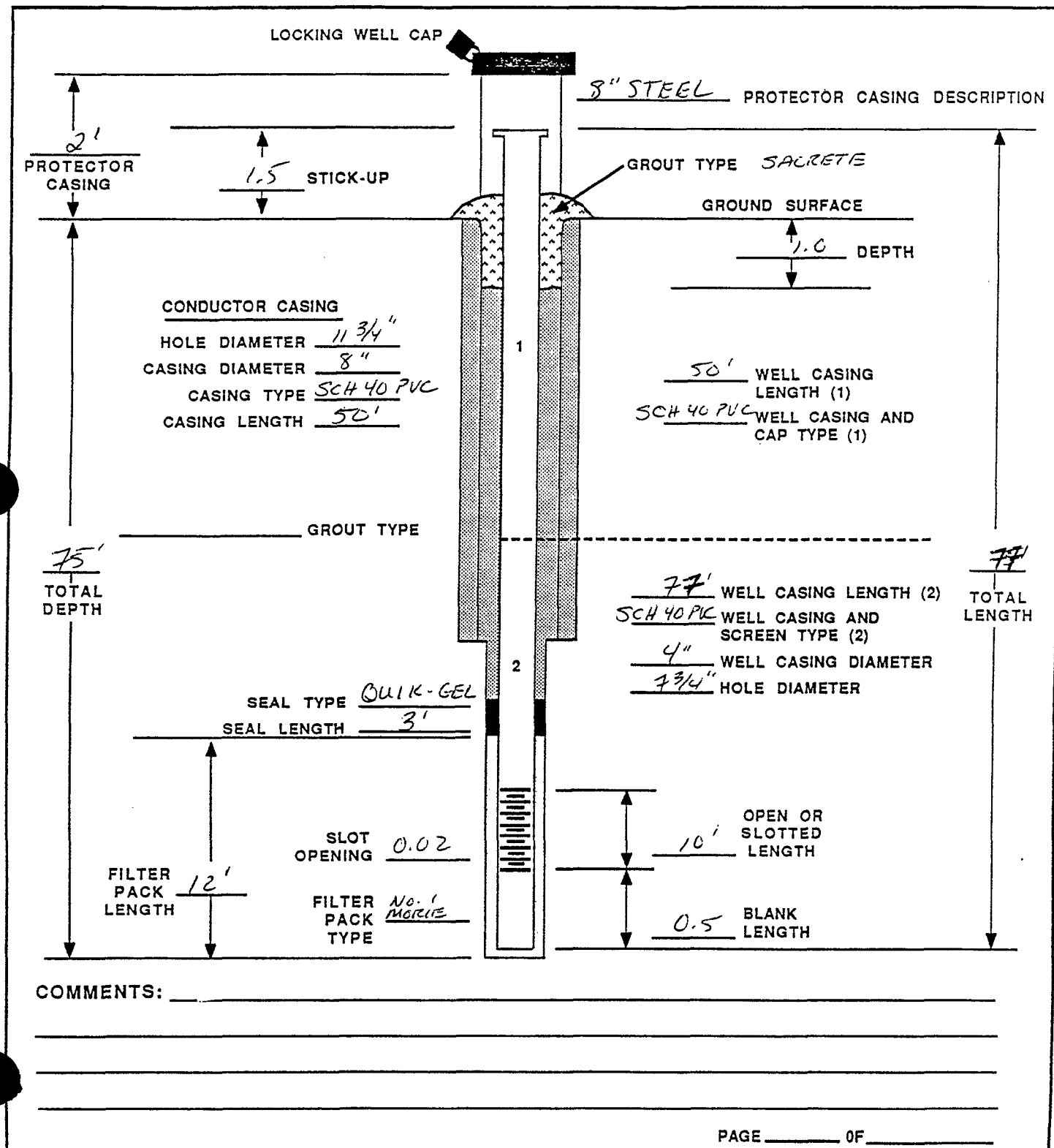


COMMENTS: Once bentonite seal was placed augers were lifted.
14' of hole caved in Bentonite/cement grout - 14 feet
SEE WELL LOG FOR 11 C OR 11 D FOR LITHOLOGY

Drawn 7/17/91

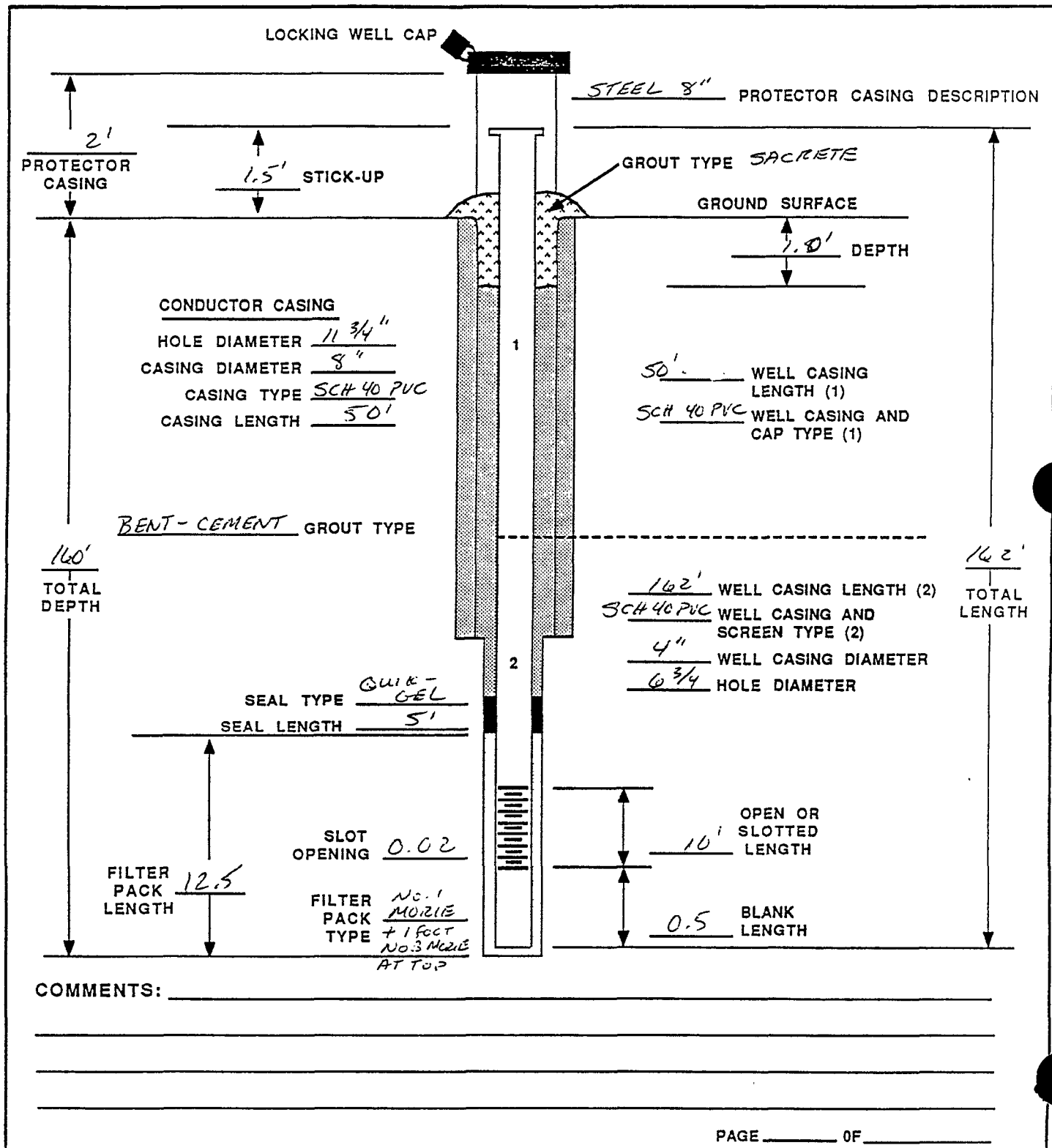
AR301327

PROJECT: DOVER GAS LIGHT JOB NUMBER: 6527
 LOCATION: NEAR CITY SHOP
 WELL NUMBER: MW 11C ELEVATION: GROUND: 8.74 ; CASING: 10.33
 DATE INSTALLED: 7/10/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



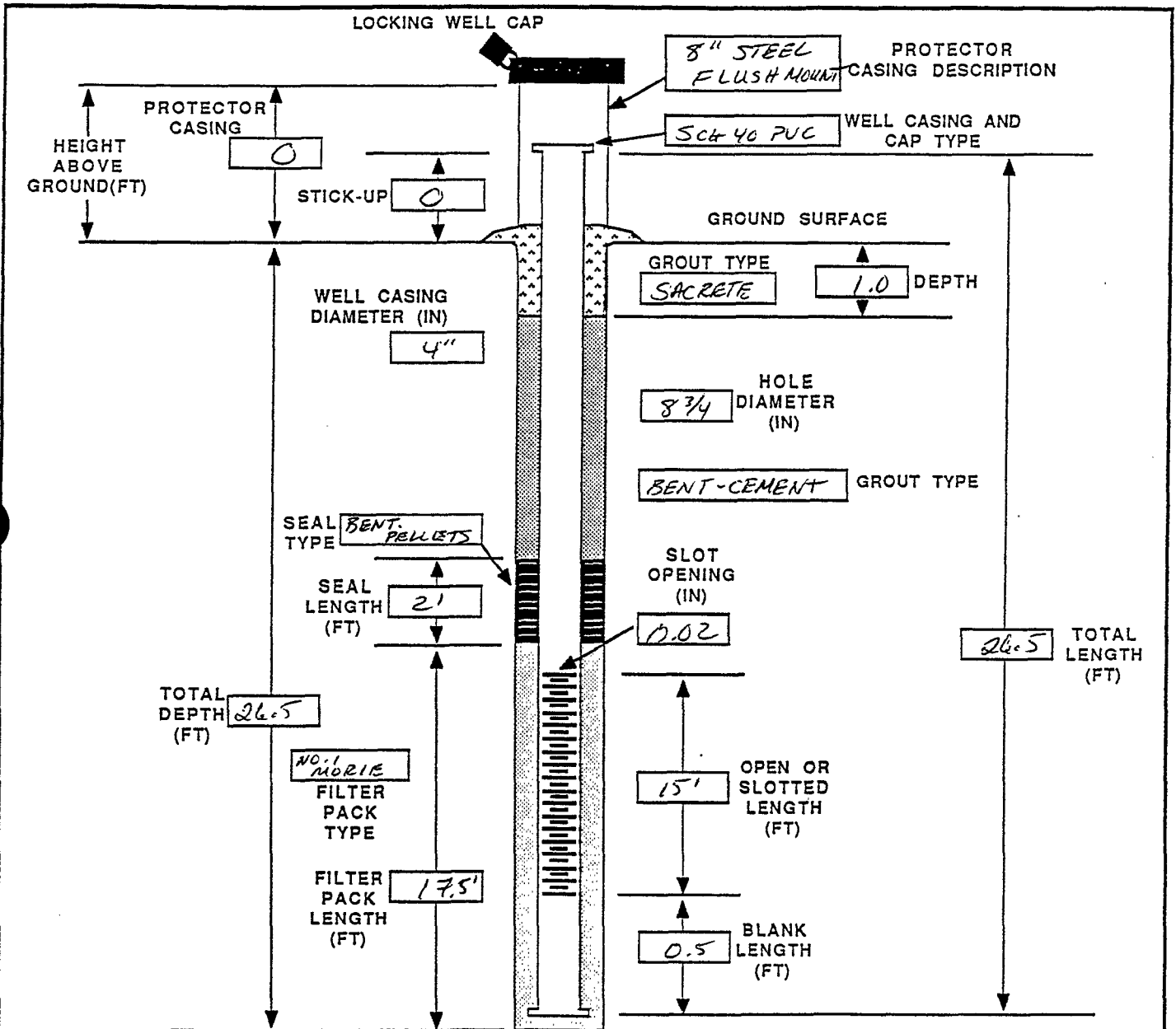
AR301328

PROJECT: DOVER GAS LIGHT JOB NUMBER: 6527
 LOCATION: NEAR CITY SHOP
 WELL NUMBER: MW 11D ELEVATION: GROUND: 8.83 ; CASING: 10.55
 DATE INSTALLED: 7/9/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



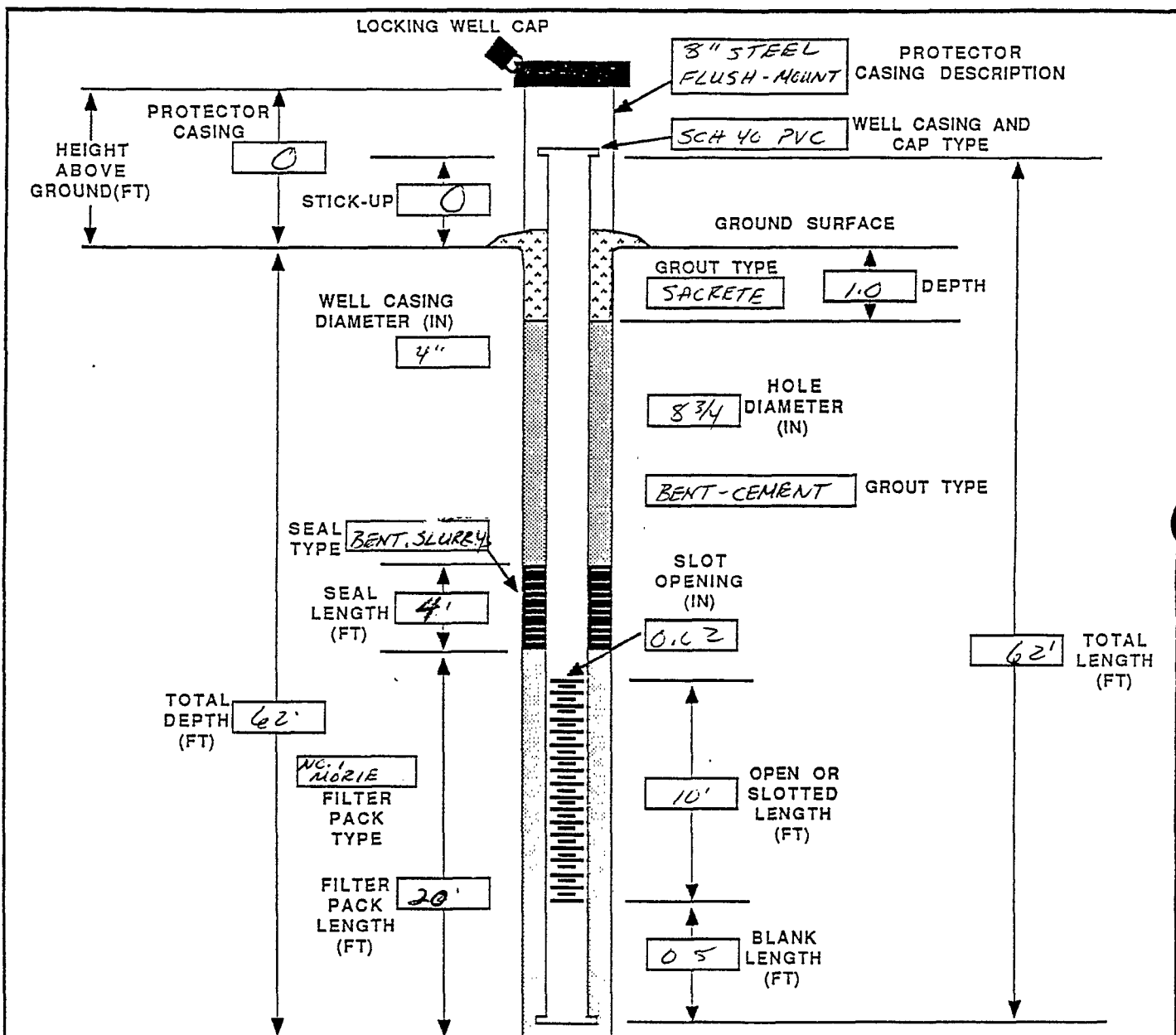
AR301329

PROJECT: DOVER GAS LIGHT JOB NUMBER: 6527
 LOCATION: COUNTY BUILDING PARK LOT WATER ST
 WELL NUMBER: MW 12A ELEVATION: GROUND: 27.00 CASING: 26.60
 DATE INSTALLED: 8/2/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



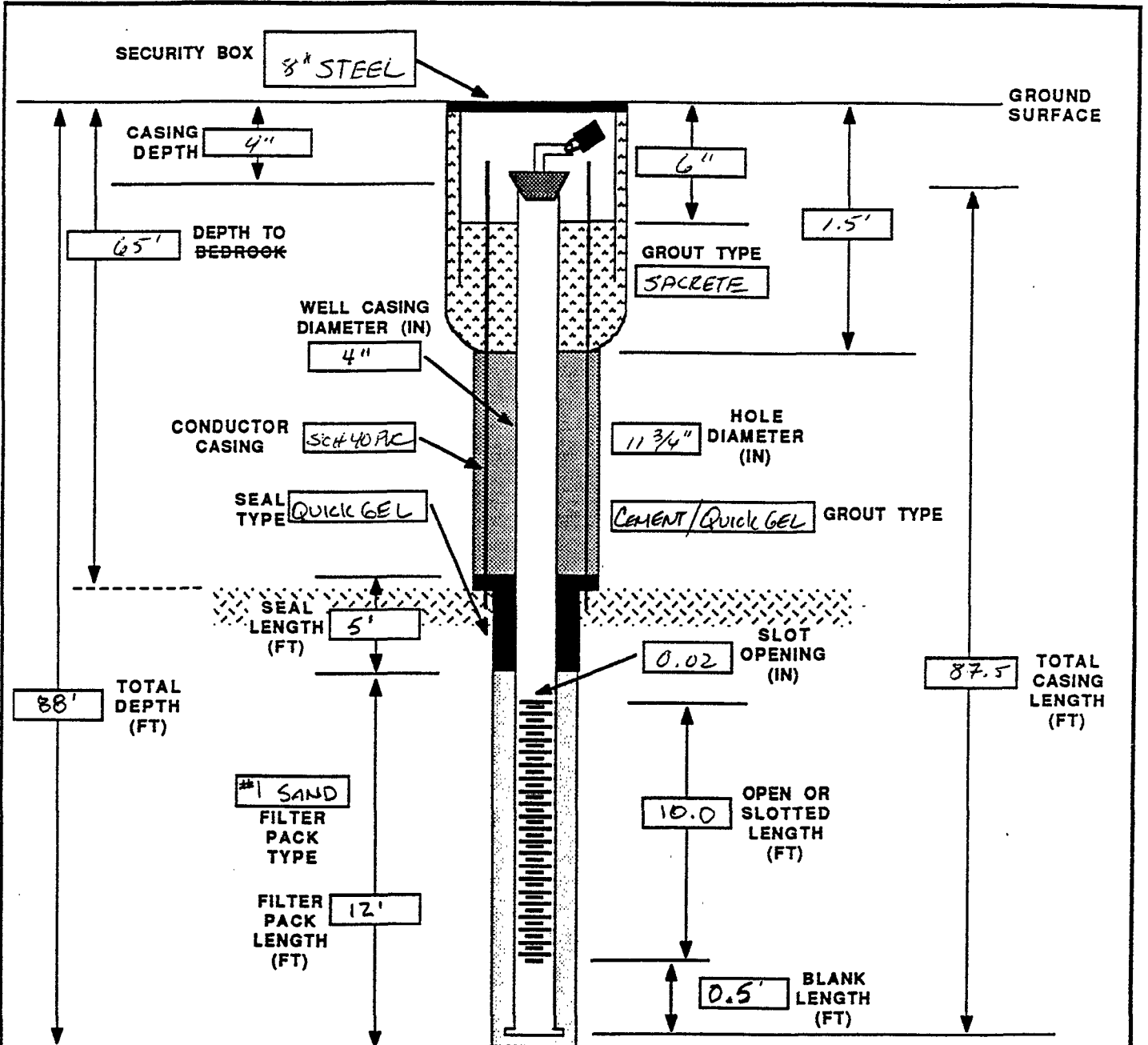
COMMENTS: WELL IS FLUSH-MOUNT, NOT AS DRAWN

PROJECT: DOVER GAS LIGHT JOB NUMBER: 6527
 LOCATION: COUNTY BUILDING PARKING LOT WATER ST
 WELL NUMBER: MW 12 B ELEVATION: GROUND: 27.10 ; CASING: 26.75
 DATE INSTALLED: _____
☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



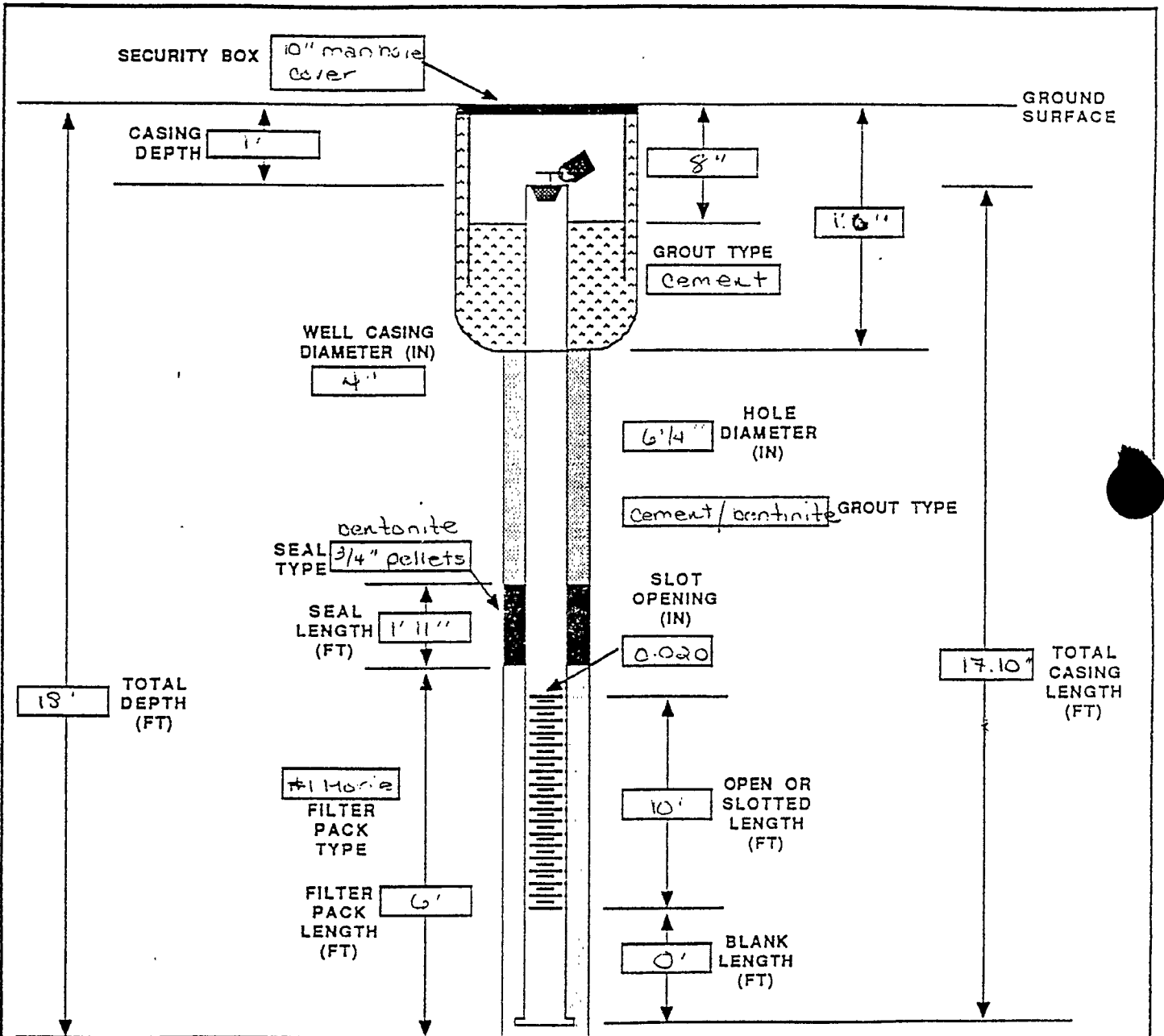
COMMENTS: WELL IS FLUSH-MOUNT, NOT AS DRAWN.
SEE WELL LOG FOR MW 12C FOR LITHOLOGY

PROJECT: DOVER Gas & Light JOB NUMBER: 6527
 LOCATION: SOUTH PARKING LOT ON WATER ST (COUNTY BUILDING)
 WELL NUMBER: MW 12 C ELEVATION: GROUND: 37.06 ; CASING: 26.79
 DATE INSTALLED: 7/24 - 7/30/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



COMMENTS: _____

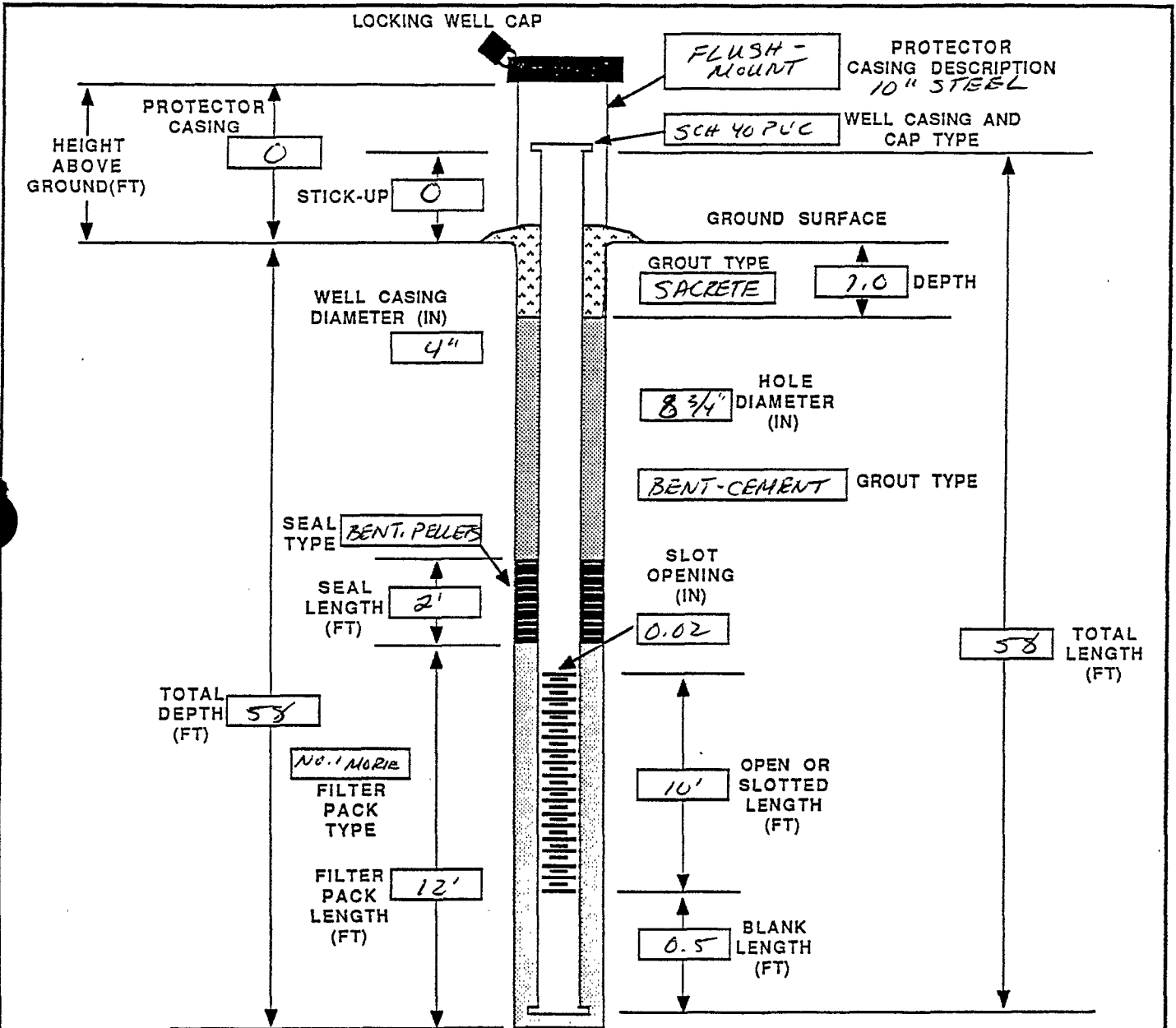
PROJECT: Chesapeake Utilities JOB NUMBER: 6527
 LOCATION: Dover Delaware - CREDIT UNION PARKING - WATER ST.
 WELL NUMBER: MW 13A ELEVATION: GROUND: 19.69; CASING: 19.29
 DATE INSTALLED: 7/19/01 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



COMMENTS: water level = 13'

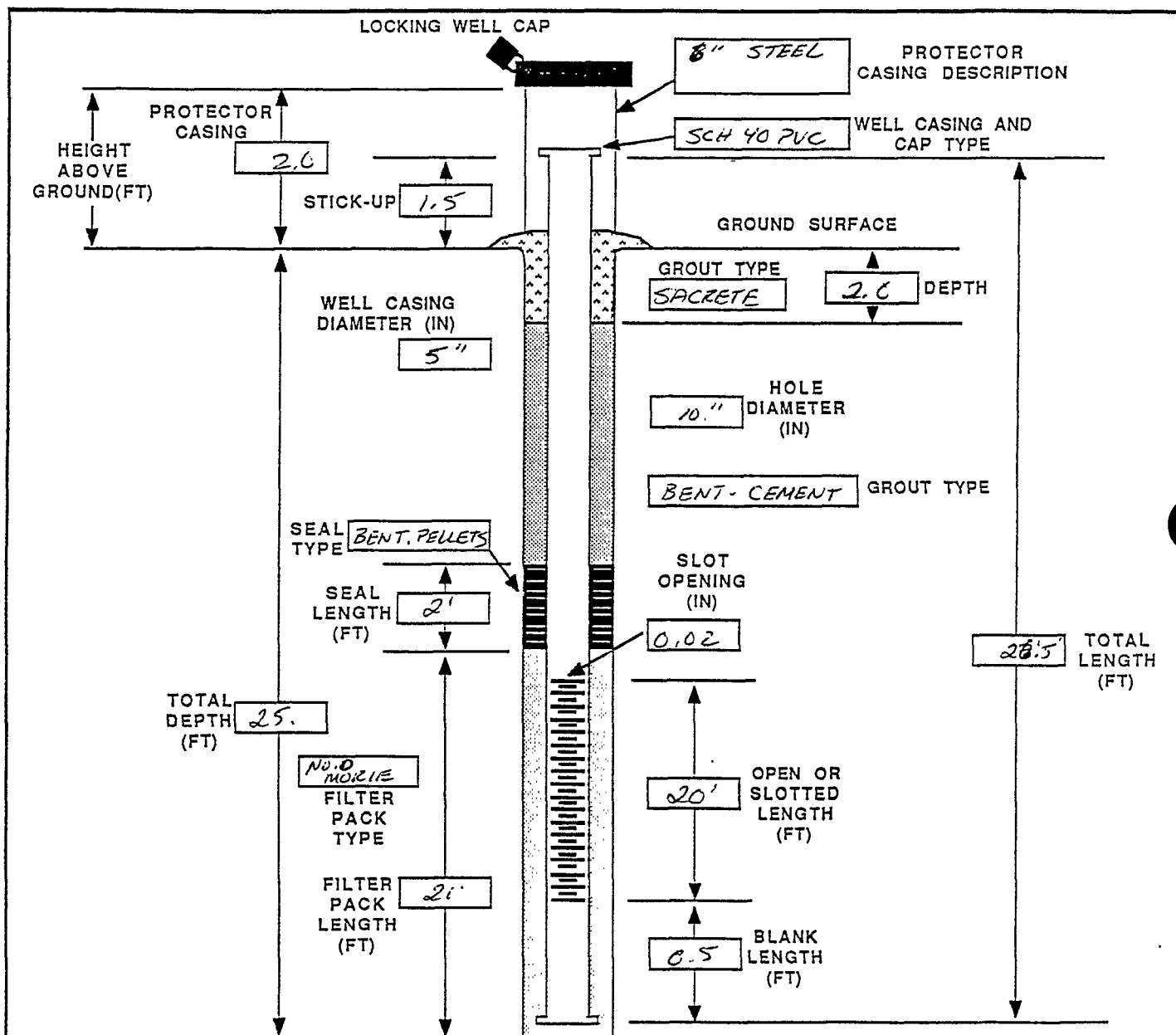
P.W.Guy 7/23/01

PROJECT: DOVER GAS LIGHT JOB NUMBER: 6527
 LOCATION: CREDIT UNION PARKING LOT
 WELL NUMBER: 13B ELEVATION: GROUND: 19.98; CASING: 19.67
 DATE INSTALLED: 8/7/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☐ ABOVE MEAN SEA LEVEL



COMMENTS: WELL IS FLUSH-MOUNT, NOT AS DRAWN

PROJECT: DOVER GAS LIGHT JOB NUMBER: 6522
 LOCATION: MUSEUM PARKING LOT, EAST SIDE
 WELL NUMBER: MW 15 A ELEVATION: GROUND: 27.34', CASING: 26.59'
 DATE INSTALLED: 4/3/91 ☐ GROUND ☐ CASING ☐ PROTECTOR CASING
☐ ABOVE GROUND LEVEL ☒ ABOVE MEAN SEA LEVEL



COMMENTS: 4 Steel POSTS LATER INSTALLED AROUND WELL.

APPENDIX C
GEOPHYSICAL LOGS

ELECTRIC

DELMARVA DRILLING COMPANY, INC.
BRIDGEVILLE, DE

LOG

COMPANY VERSAR, Inc.

WELL NO. M66C

COUNTY DOVER GAS LIGHT SITE

STATE DOVER, DE

RECORDED BY B. Hartman

DATE 8/6/91

WITNESSED BY Ken DeRoche

DATE 8/6/91

TYPE OF LOG Electric & Gamma

DATE 8/6/91

FOOTAGE 91 1/2'

TOTAL DEPTH 92

I. D. DRILLER 6-3/4"

LOG MEAS. FROM Ground

DRILLING MEAS. FROM Ground

PERMANENT DATUM Ground

WEIGHT

VISCOSITY

PH

RESISTIVITY 10 ohms/in

POTENTIAL 25 mv/in

ELECTRODE SPACING

SYMMETRICAL

NON-SYMMETRICAL

FLUID LEVEL

LGTH. MEAS. DEVICE-IN 10'

O. D. OF INSTRUMENT-IN 2"

TIME CONSTANT-SECONDS

LOGGING SP. - FT./MIN. 25 ft/min

STATISTICAL VAR-IN

SENSITIVITY REF.

Gamma = 5 counts/in

WELL RECORD

WELL SIZE 8"x4"

DEPTH 85'

BOT. OF OUTER CASING 62'

TOP OF SCREEN 75'

BOT. OF SCREEN 85'

SIZE OF SCREEN 4" P.S.

SLOT SIZE .020

MATERIAL PVC F.J.

CRAVEL SIZE Nottle #1

DEPTH TO R-L NIPPLE n/a

PUMPING TEST

DATE

CAPACITY

STATIC LEVEL

DRAWDOWN

PUMPING LEVEL

SP. CAPACITY

REMARKS OR OTHER DATA

PRINTED IN U.S.A.

NO. 101 3172

LOG-MARTIN SERVICES

501-337

ELECTRIC

DELMARVA DRILLING COMPANY, INC.
BRIDGEVILLE, DE

LOG

COMPANY VERSAR, Inc.

WELL NO. M6C

COUNTY DOVER GAS LIGHT SITE

STATE DOVER, DE

RECORDED BY Jim Schultes

DATE 8/1/91

WITNESSED BY Ken DeLoche

DATE 8/1/91

TYPE OF LOG Electric & Gamma

DATE 8/1/91

FOOTAGE 62'

TOTAL DEPTH 62'

I. D. DRILLER 12"

LOG MEAS. FROM Ground

DRILLING MEAS. FROM Ground

PERMANENT DATUM Ground

WEIGHT

VISCOSITY

PH

RESISTIVITY 25 ohms/in

POTENTIAL 50 mv/in

ELECTRODE SPACING

SYMMETRICAL

NON-SYMMETRICAL

FLUID LEVEL

LGTH. MEAS. DEVICE-IN 10"

O. D. OF INSTRUMENT-IN 2"

TIME CONSTANT-SECONDS

LOGGING SP - FT/MIN. 25 ft/min

STATISTICAL VAR-IN

SENSITIVITY REF.

Gamma = 12.5 counts/in

WELL RECORD

WELL SIZE

DEPTH

BOT. OF OUTER CASING

TOP OF SCREEN

BOT. OF SCREEN

SIZE OF SCREEN

SLOT SIZE

MATERIAL

GRAVEL SIZE

DEPTH TO R-L NIPPLE

PUMPING TEST

DATE

CAPACITY

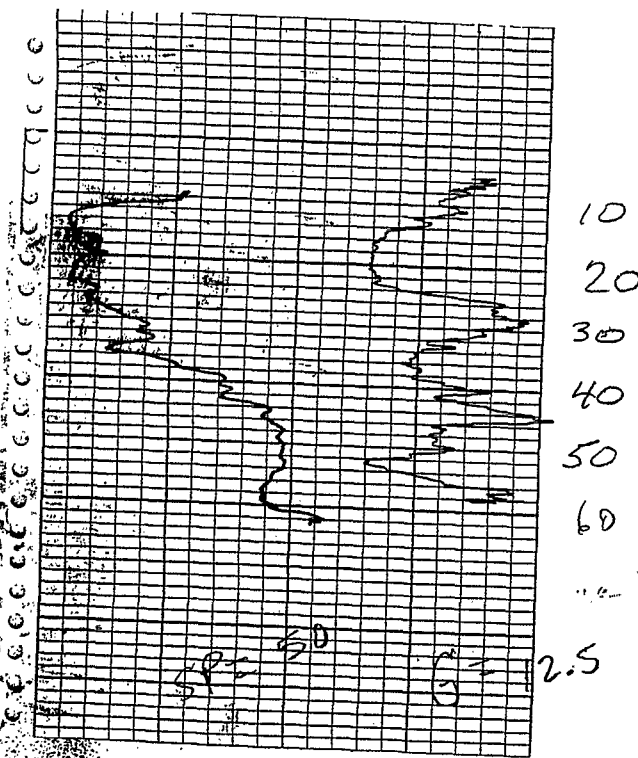
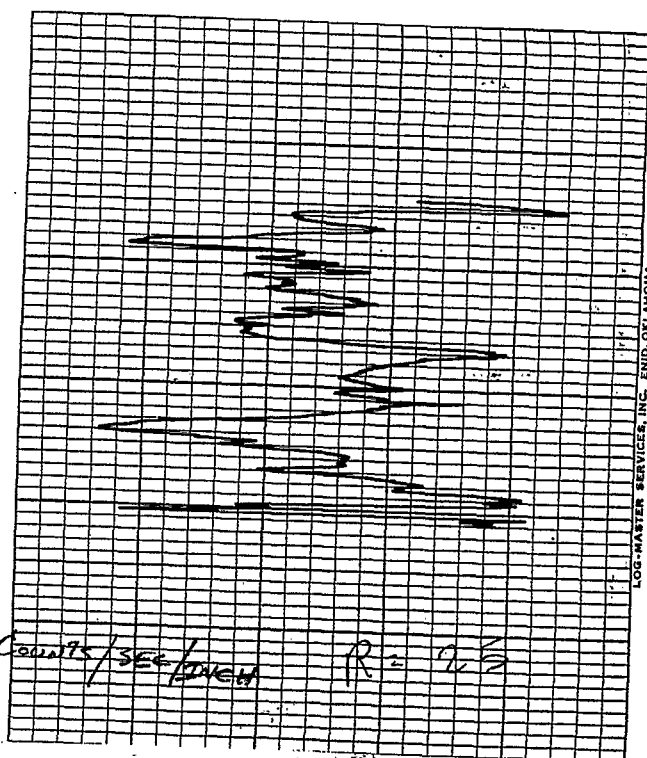
STATIC LEVEL

DRAWDOWN

PUMPING LEVEL

SP. CAPACITY

REMARKS OR OTHER DATA



ELECTRIC DELMARVA DRILLING COMPANY, INC.
BRIDGEVILLE, DE

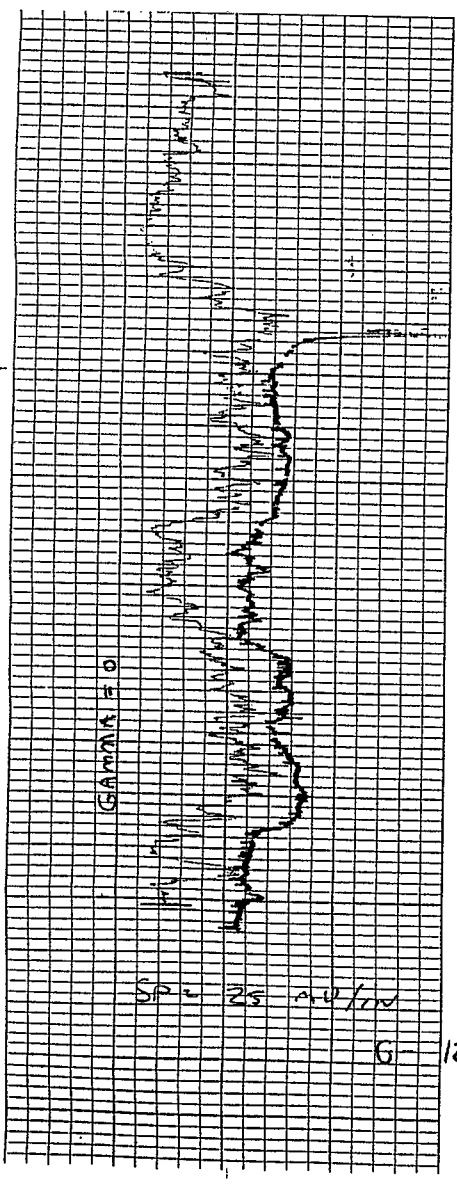
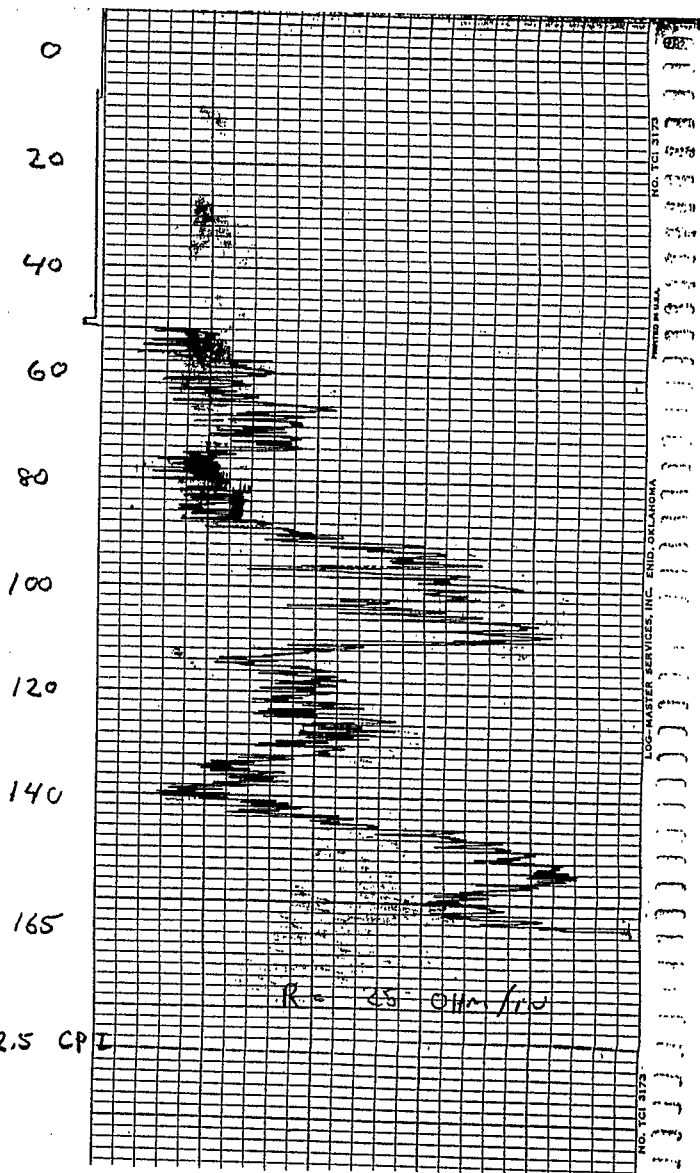
LOG

COMPANY VERSAR
WELL NO. 11D
LOG TYPE Dover Gas Light
STATE Dover, DE

RECORDED BY Brad Hartman
DATE 7/3/91
WITNESSED BY Ken DeRoche
DATE 7/3/91

TYPE OF LOG <u>Electric & Gamma</u>	WELL RECORD
DATE <u>7/3/91</u>	WELL SIZE <u>4"</u>
FOOTAGE <u>165</u>	DEPTH <u>165</u>
TOTAL DEPTH <u>165</u>	BOT. OF OUTER CASING
L. D. DRILLER <u>6"</u>	TOP OF SCREEN
LOG MEAS. FROM <u>Ground</u>	
DRILLING MEAS. FROM <u>Ground</u>	
PERMANENT DATUM <u>Ground</u>	
WEIGHT	
VISCOSITY	
PH	
RESISTIVITY <u>25 ohms/in</u>	BOT. OF SCREEN
POTENTIAL <u>25 mv/in</u>	SLOT SIZE
ELECTRODE SPACING	MATERIAL
SYMMETRICAL	GRAVEL SIZE
NON-SYMMETRICAL	DEPTH TO R-L NIPPLE
FLUID LEVEL	
LOTH. MEAS. DEVICE-IN <u>10'</u>	
O. D. OF INSTRUMENT-IN <u>2"</u>	
TIME CONSTANT-SECONDS	
LOGGING SP. - FT/MIN. <u>25 ft/min</u>	
STATISTICAL VAR-IN	
SENSITIVITY REF. <u>Gamma = 12.5 COUNTS</u>	
PER. LOG, Gamma measures 2 feet above electric	

REMARKS OR OTHER DATA



AR301339

ELECTRIC

DELMARVA DRILLING COMPANY, INC.
BRIDGEVILLE, DE

LOG

COMPANY VERSAR, Inc.

WELL NO. MW13B

COUNTY DOVER GAS LIGHT SITE

STATE DOVER, DE

RECORDED BY Tim Parks

DATE 8/7/91

WITNESSED BY Jeff DeCarlo

DATE 8/7/91

TYPE OF LOG Electric & Gamma

DATE 8/7/91

FOOTAGE 62'

TOTAL DEPTH 62'

I. D. DRILLER 6-3/4"

LOG MEAS. FROM Ground

DRILLING MEAS. FROM Ground

PERMANENT DATUM Ground

WEIGHT

VISCOSITY

PH

RESISTIVITY 25 ohm/in

POTENTIAL 25 ohm/in

ELECTRODE SPACING

SYMMETRICAL

NON-SYMMETRICAL

FLUID LEVEL

LGTH. MEAS. DEVICE-IN 10'

O. D. OF INSTRUMENT-IN 2"

TIME CONSTANT-SECONDS 25 ft/min

LOGGING SP. - FT/MIN. 25 ft/min

STATISTICAL VAR-IN

SENSITIVITY REF.

Gamma = 12.5 counts/in

WELL RECORD

WELL SIZE

DEPTH

BOT. OF OUTER CASING

TOP OF SCREEN

BOT. OF SCREEN

SIZE OF SCREEN

SLOT SIZE

MATERIAL

GRAVEL SIZE

DEPTH TO R-L NIPPLE

PUMPING TEST

DATE

CAPACITY

STATIC LEVEL

DRAWDOWN

PUMPING LEVEL

SP. CAPACITY

REMARKS OR OTHER DATA

